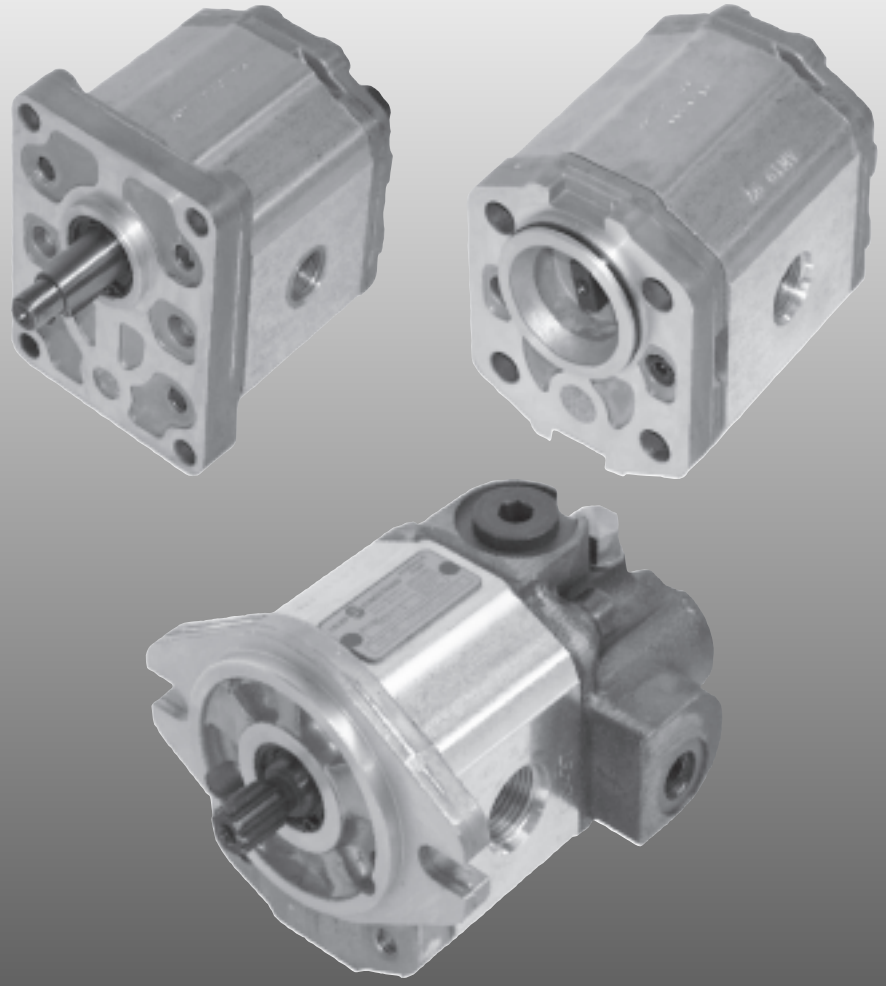
SAUER DANFOSS

Group 2



Gear Pumps and Motors

Service Manual

1. Introduction

1.1 Using This Manual

The purpose of this manual is to provide useful information concerning assembling and disassembling of Group 2 pumps and motors. In order to obtain the maximum performance from this series of components, we recommend special attention be given to the suggestions and recommendations included.

This manual gives a general description of the design of the units. It also details disassembling and assembling procedures for single units (pumps and motors). It then follows-up with the multistage units, explaining how to combine or separate into single stages. A special section is devoted to describe how to change the rotation of the pump or motor. The appendix gives information on testing and relative specifications. A list follows including the special tools necessary for the operations described in the previous sections.
This manual gives only general procedures for servicing and does not give part numbers of single products or single components. If this information is required, please contact Sauer-Danfoss.

All of the information contained in this manual is accurate at the date of printing. Sauer-Danfoss reserves the right to change any specifications without prior notice.

1.2 Safety Precautions

Always consult the equipment's operator manual for specific safety warnings prior to approaching a machine. Hydraulic components may be located in close proximity to sharp and/or hot components; always take appropriate precautions.

Flammable Cleaning Solvents

⚠ WARNING

Some cleaning solvents are flammable. To reduce risk of fire, do no use cleaning solvents in an area where a source of ignition may be present.

Personal Safety

⚠ WARNING

Proper safety equipment, including safety glasses, should be used at all times.

Disable Work Function

⚠ WARNING

Certain service procedures may require the vehicle/ machine to be disabled while performing them in order to protect the technician and bystanders.

Fluid Under High Pressure

⚠ WARNING

Use caution when dealing with hydraulic fluid under pressure. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin causing serious injury. This fluid may also be hot enough to burn. If cut or burned by hydraulic fluid, seek proper medical attention immediately.

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Contents

1. Introduction 2
1.1 Using This Manual 2
1.2 Safety Precautions 2
1.3 Symbols Used in Sauer-Danfoss Literature 5
2. General Information 6
2.1 General Description 6
2.2 Design 7
2.3 Model Code 8
3. Technical Specifications 10
3.1 Hardware Specifications 10
3.2 System Specifications 11
3.3 Fluids and Filtration 11
4. Servicing 12
4.1 Conversions 12
4.1.1 Recommendations 12
4.2 Conversion Tables 12
5. Disassembly 14
5.1 General 14
5.1.1 Cleanliness 14
5.1.2 Lubrication of Moving Parts 14
5.1.3 Care of Surface Treatment 14
5.1.4 Marking the Parts 14
5.1.5 Procedure 15
6. Assembly 19
7. Multi Stage Pumps 27
7.1 General 27
7.1.1 Construction 27
7.2 First Stage Pump Preparation 28
7.2.1 General 28
7.2.2 Model Code 28
7.2.3 Converting a Single Stage Pump to a First Stage Pump 29
7.2.4 Conversion Procedure 29
7.3 Intermediate Stage Pump Preparation 30
7.3.1 General 30
7.3.2 Model Code 30
7.3.3 Converting a Single Stage Pump to an Intermediate Stage Pump 31
7.3.4 Conversion Procedure 31
7.4 Final Stage Pump Preparation 32
7.4.1 General 32
7.4.2 Model Code 32
7.4.3 Converting to a Rear Stage Pump 33
7.4.4 Conversion Procedure 33
7.5 Assembly of Multi-Stage Pumps 34
7.6 Change of Rotation 35
7.6.1 General 35
7.6.2 Determining the Direction of Rotation 35
7.6.3 Model code 36
7.6.4 Conversion procedure 36

8. SKP2 Pumps 39
8.1 General Information 39
8.1.2 Drive Gear Shaft Differences 40
8.1.3 Front and Rear Flange Differences 40
8.1.1 Bearing Block For SKP2 40
8.1.4 Bearing Block Differences 41
8.2 Changing the Rotation of SKP2 42
9. Product Options 44
9.1 Rear Cover with Integral Priority Flow Divider Valve 44
9.1.1 General Information 44
9.1.2 Disassembly and Reassembly 44
9.2 Rear Cover with Integral Relief Valve 45
9.2.1 General Information 45
9.2.2 Disassembly and Reassembly 45
10. Trouble Shooting 46
10.1 Low or No Flow From Gear Pump 46
10.2 Excessive Noise 46
10.3 External Leakage 46
11. Appendix 48
11.1 Stud Specifications 48
11.2 Stud Length For Multi-Stage Pumps 48
11.2.1 Tandem Pumps 48
11.2.2 Multi-Stage Pumps (General Rule) 49
11.2.3 Component Lengths 49
11.3 Testing the Pumps and Motors 50
11.3.1 General 50
11.3.2 Test Procedure 50
11.3.3 Tables 50
11.3.3 Tables (cont.) 51
11.4 Tools 52
11.4.1 Shaft Seal Installation Tool 52
11.4.2 Shaft Seal Protective Sleeves 53
11.5 Shaft Dimensions 54
11.5.1 Shafts Used with 01 Flange 54
11.5.2 Shafts Used with 02 Flange 56
11.5.3 Shafts Used with 04 / 05 Flange 57
11.5.4 Shafts Used with 06 Flange (SAE) 58
11.5.5 FR Tang Shaft 60
11.5.6 Mating Design for FR03 Pumps 60
11.6 Flange Types 61

1.3 Symbols Used in Sauer-Danfoss Literature

DANGER! May result in injury.

May result in immediate or premature damage.

Reusable part.

Nonreusable part, use a new part.

Non-removable item.

“OR” in drawing - either option may exist.

Measurement required.

Flatness specification.

Parallelism specification.

External hex.

Internal hex.

Torx head.

Lubricate with hydraulic fluid.

Apply grease/petroleum jelly.

Apply locking compound.

Inspect for ware or damage.

Clean area or part.

Be careful no to scratch or damage

Note correct orientation.

Mark orientation for reinstallation.

Torque Specification.

Press in.

Pull out with tool.

Use installation sleeve/cone (bullet).

P101 128

P101 129

2. General Information

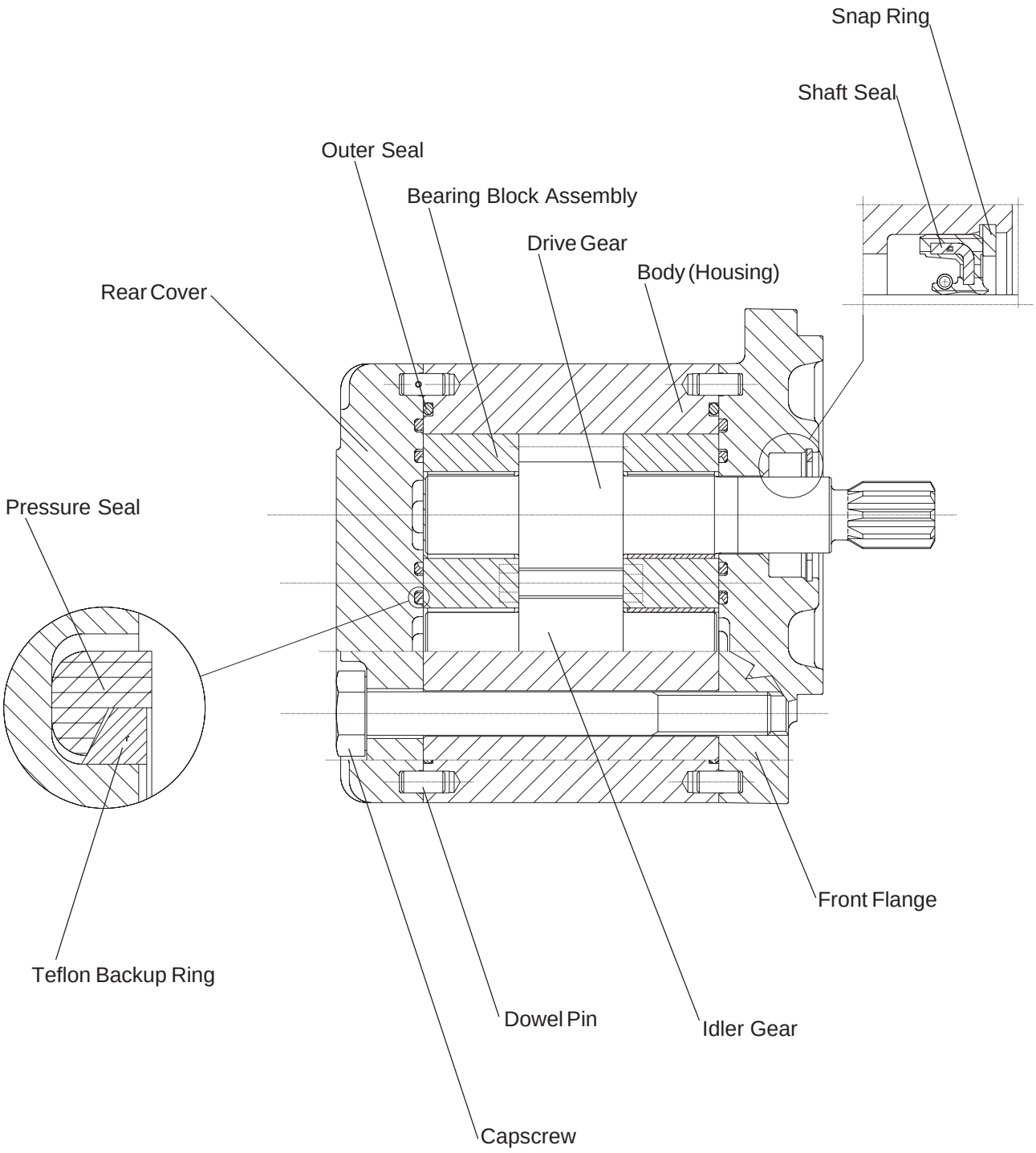
2.1 General Description

Group 2 gear products consist of pumps, reversible pumps, uni- and bidirectional motors. This group of gear pumps and motors is characterized by a wide selection of components. It is possible to have a wide range of units resulting from a common base of components or processes. This manual describes the service procedures that can be applied to all the products of this range. The complete range of products detailed in this manual are:

- **SNP 2** Standard gear pump
- **SEP 2** Gear pump, similar to SNP2, without DU-Bushings (Cost Effective Model)
- **SHP 2** Gear pump, similar to SNP2, with longer shaft journal bearings (high performance model)
- **SKP 2** Gear pump, similar to SNP2, with larger shaft specially designed to accommodate SAE 11 tooth spline
- **SNU 2** Unidirectional gear motor, similar to SNP2 pump
- **SNM 2** Standard bidirectional gear motor
- **SEM 2** Bidirectional gear motor, similar to SNM2, with lower pressure limits (Cost effective model)
- **SNR 2** Bidirectional gear pump.
- **SHM 2** Bidirectional gear motor, similar to SHP2 pumps, with longer shaft journal bearings, and higher pressure rating than SNM2

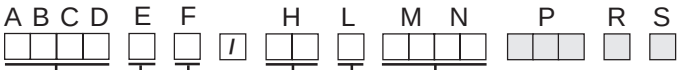
Generally, all these products follow the same procedures for assembling, disassembling, and servicing. In this manual, the SNP2 will be used as an example for all unidirectional pumps and motors (SNP/SEP/SHP/SNU 2), and the SNM2 for all the bi-direction pumps and motors (SNM/SEM/SNR/SHM 2). SKP assembly and disassembly information will be handled in a separate section of this manual.

2.2 Design



P101 130

2.3 Model Code



Type
- **SNP 2** = Standard Gear Pump
- **SKP 2** = High Torque Gear Pump
- **SHP 2** = High Pressure Gear Pump
- **SNI 2** = Gear Pump with Internal Drain Relief Valve
- **SNE 2** = Gear Pump with External Drain Relief Valve

Valve (omit when not used)
- **U** = Priority Flow Divider with Pilot Relief Valve
- **L** = Priority Flow Divider with Pilot Relief Valve and Static Load Sensing
- **N** = Priority Flow Divider with Pilot Relief Valve and Dynamic Load Sensing
- **P** = Priority Flow Divider with Full Flow Relief Valve
- **F** = Priority Flow Divider with Full Flow Relief Valve and Static Load Sensing
- **V** = Priority Flow Divider with Full Flow Relief Valve and Dynamic Load Sensing

Valve Port Position (omit when not used)
- **S** = Side Ports
- **R** = Rear Ports

Displacement

		cm^3/rev	/	[in^3/rev]
4	=	3.9	/	[0.24]
6	=	6.0	/	[0.37]
8	=	8.4	/	[0.51]
11	=	10.8	/	[0.66]
14	=	14.4	/	[0.88]
17	=	16.8	/	[1.02]
19	=	19.2	/	[1.17]
22	=	22.8	/	[1.39]
25	=	25.2	/	[1.54]

Direction of Rotation
- **D** = Right (Clockwise)
- **S** = Left (Anti-clockwise)

Input Shaft / Mounting Flange / Port Configuration

CO Tapered shafts, 1:5 or 1:8
- **CO01** = 1:8 tapered shaft / European four bolt flange / European flanged ports
- **CO02** = 1:5 tapered shaft / German four bolt PTO flange / German standard ports
- **CO04** = 1:5 tapered shaft / German two bolt PTO flange (Deutz) / German standard ports
- **CO05** = 1:5 tapered shaft / German two bolt PTO flange (Deutz) / German standard ports
- **CO09** = 1:8 tapered shaft / Perkins 4.236 timing case flange / European flanged ports
- **CO09** = (*variant BBM*) 1:8 tapered shaft / Perkins 900 series flange / German standard ports
- **CO0B** = 1:8 tapered shaft / Perkins 1000 series left side PTO flange / European flanged ports
- **CO91** = (*variant LBD*) 1:8 tapered shaft / European four bolt flange / European flanged ports / equipped with outrigger bearing
- **CO94** = 1:5 tapered shaft / German two bolt PTO flange (Deutz) / German standard ports / equipped with outrigger bearing

CI Parallel shafts, 15mm or 15.875mm
- **CI01** = 15mm [.591 in] parallel shaft / European four bolt flange / European flanged ports
- **CI06** = 15.875mm [.625 in] parallel shaft / SAE "A" flange / SAE O-ring boss ports
- **CI96** = (*variant LEP*) 19.05mm [.750 in] parallel shaft / SAE "A" flange / SAE O-ring boss ports / equipped with outrigger bearing

SC Splined shafts, DIN B17x14, SAE 9T 16/32p, or SAE 11T 16/32p (SKP 2 only)
- **SC01** = DIN splined shaft / European four bolt flange / European flanged ports
- **SC02** = DIN splined shaft / German four bolt PTO flange / German standard ports
- **SC04** = DIN splined shaft / German two bolt PTO flange (Deutz) / German standard ports
- **SC05** = DIN splined shaft / German two bolt PTO flange (Deutz) / German standard ports
- **SC06** = SAE splined shaft / SAE A flange / SAE O-ring boss ports
- **SC36** = SAE splined shaft / SAE A flange plus SAE A auxiliary mounting pad / SAE O-ring boss ports

FR Sauer-Danfoss tang shaft
- **FR03** = Sauer-Danfoss tang shaft / flanged for multiple configuration / German standard ports

Variant Code (Three letter code describes valve settings or other variants to standard configuration)

- **BBM** = Variation on 09 flange to accommodate Perkins 900 series engine mounting
- **LEP** = Variant on standard straight shaft used with CI96 outrigger bearing option.
- **LBD** = Variant on standard tapered shaft used on CO91 outrigger bearing option.
- **U**** **Integral flow divider**
  - Pressure setting at controlled flow [bar] / (psi)

L	=	[60]	(870)	**T**	=	[140]	(2030)
M	=	[70]	(1015)	**C**	=	[150]	(2175)
N	=	[80]	(1160)	**U**	=	[160]	(2320)
O	=	[90]	(1305)	**D**	=	[170]	(2465)
P	=	[100]	(1450)	**V**	=	[180]	(2611)
Q	=	[110]	(1595)	**E**	=	[190]	(2755)
R	=	[120]	(1740)	**X**	=	[200]	(2901)
S	=	[130]	(1885)				

  - Controlled flow [l/min] / (US gal/min)

M	=	[8]	(2.11)	**J**	=	[18]	(4.75)
F	=	[10]	(2.64)	**Q**	=	[20]	(5.28)
N	=	[12]	(3.17)	**K**	=	[22]	(5.80)
O	=	[14]	(3.70)	**R**	=	[24]	(6.34)
P	=	[16]	(4.23)	**I**	=	[26]	(6.86)

- **V**** **Integral relief valve**
  - Pressure setting [bar] / (psi)

A	=	No setting		**O**	=	[90]	(1305)
B	=	No valve		**P**	=	[100]	(1450)
C	=	[18]	(261)	**Q**	=	[110]	(1595)
D	=	[25]	(363)	**R**	=	[120]	(1740)
E	=	[30]	(435)	**S**	=	[130]	(1885)
F	=	[35]	(508)	**T**	=	[140]	(2030)
G	=	[40]	(580)	**U**	=	[160]	(2320)
K	=	[50]	(725)	**V**	=	[170]	(2465)
L	=	[60]	(870)	**W**	=	[180]	(2611)
M	=	[70]	(1015)	**X**	=	[210]	(3045)
N	=	[80]	(1160)	**Z**	=	[250]	(3626)

  - Pump speed for relief valve setting (min^{-1} (rpm))
    - **A** = Not defined
    - **C** = 500
    - **E** = 1000
    - **F** = 1250
    - **G** = 1500
    - **K** = 2000
    - **I** = 2250
    - **L** = 2500
    - **M** = 2800
    - **N** = 3000
    - **O** = 3250

Version (Value representing a change to the initial project)

- **.** = Initial project
- **1..9 A..Z** = Reserved to

Port Type (If other than standard)

- **.** = Standard port for the flange type specified
- **B** = Flanged port with threaded holes in "X" pattern (German standard ports), centered on the body
- **C** = Flanged port with threaded holes in "+" pattern (European Standard)
- **E** = Threaded SAE o-ring boss port
- **F** = Threaded Gas port (BSP)
- **G** = Flanged port with threaded holes in "X" pattern (German standard ports), offset from center of body

3. Technical Specifications

3.1 Hardware Specifications

Pump Model		4	6	8	11	14	17	19	22	25
Displacement	cm^3/rev [in^3/rev]	3.9 [0.24]	6.0 [0.37]	8.4 [0.51]	10.8 [0.66]	14.4 [0.88]	16.8 [1.02]	19.2 [1.17]	22.8 [1.39]	25.2 [1.54]
SNP										
Peak Pressure	bar [psi]	280 [4060]	280 [4060]	280 [4060]	280 [4060]	280 [4060]	280 [4060]	230 [3335]	200 [2900]	175 [2538]
Rated Pressure	bar [psi]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	210 [3045]	180 [2610]	160 [2320]
Minimum Speed at 0-100 bar	min^{-1} (rpm)	600	600	600	500	500	500	500	500	500
Minimum Speed at 100-180 bar	min^{-1} (rpm)	1200	1200	1000	800	750	750	700	700	700
Minimum Speed at 180 bar to rated pressure	min^{-1} (rpm)	1400	1400	1400	1200	1000	1000	1000	-	-
Maximum Speed	min^{-1} (rpm)	4000	4000	4000	4000	3500	3000	3000	3000	3000
SKP										
Peak Pressure	bar [psi]	280 [4060]	280 [4060]	280 [4060]	280 [4060]	280 [4060]	280 [4060]	260 [3770]	230 [3335]	200 [2900]
Rated Pressure	bar [psi]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	240 [3480]	210 [3045]	190 [2755]
Minimum Speed at 0-100 bar	min^{-1} (rpm)	600	600	600	500	500	500	500	500	500
Minimum Speed at 100-180 bar	min^{-1} (rpm)	1200	1200	1000	800	750	750	700	700	700
Minimum Speed at 180 bar to rated pressure	min^{-1} (rpm)	1400	1400	1400	1200	1000	1000	1000	800	800
Maximum Speed	min^{-1} (rpm)	4000	4000	4000	4000	3500	3000	3000	3000	3000
SHP										
Peak Pressure	bar [psi]							260 [3770]	230 [3335]	200 [2900]
Rated Pressure	bar [psi]							240 [3480]	210 [3045]	190 [2755]
Minimum Speed at 0-100 bar	min^{-1} (rpm)							600	600	600
Minimum Speed at 100-180 bar	min^{-1} (rpm)							800	800	800
Minimum Speed at 180 bar to rated pressure	min^{-1} (rpm)							1000	1000	1000
Maximum Speed	min^{-1} (rpm)							3000	3000	3000
ALL		The data below represent mean values for standard configured pumps.								
Weight	kg [lb]	2.3 [5.1]	2.4 [5.3]	2.5 [5.5]	2.7 [5.8]	2.9 [6.3]	3.0 [6.5]	3.1 [6.7]	3.2 [7.0]	3.3 [7.3]
Moment of Inertia of rotating components	$x10^{-6}$ kg m^2 [$x10^{-6}$ lbf ft^2]	20.6 [489]	25.7 [610]	31.5 [747]	37.3 [885]	45.9 [1089]	51.7 [1227]	57.5 [1364]	66.2 [1571]	72.0 [1709]
Theoretical Flow at Maximum Speed	l / min [US gal / min]	15.6 [4.12]	24.0 [6.34]	33.6 [8.87]	43.2 [11.4]	50.4 [13.3]	50.4 [13.3]	57.6 [15.2]	68.4 [18.0]	75.6 [20.0]

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3.2 System Specifications

Inlet Pressure	
	bar absolute
Recommended Range	**0.8 to 3.0**
Minimum (cold start)	**0.6**
	T101 001E

T101 001E

Temperature		
	°C	°F
Minimum (cold start)	**-20**	-4
Maximum Continuous	**80**	176
Peak (Intermittent)	**90**	194
		T101 003E

T101 003E

Fluid Viscosity -mm²/s (cSt) [SUS]	
Minimum	10 [60]
Recommended Range	12 to 60 [66 to 290]
Maximum (cold start)	1600 [7500]

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Fluid Cleanliness Level and β_x-Ratio	
Required Fluid Cleanliness Level (per ISO 4406)	Class 18/13 or better
Recommended β_x-Ratio (Suction Filtration)	$\beta_{35-45} = 75$ $\beta_{10} \geq 2$
Recommended β_x-Ratio (Pressure or Return Filtration)	$\beta_{15-20} = 75$ $\beta_{10} \geq 10$
Recommended Inlet Screen Size (for Pressure or Return Filtration)	100 µm-125 µm
	T101 004E

T101 004E

3.3 Fluids and Filtration

To prevent premature wear, it is imperative that only clean fluid enter the pump and hydraulic circuit. A filter capable of controlling the fluid cleanliness to Class 18/13 per ISO 4406 or better under normal operating conditions is recommended.

The filter may be located on the pump outlet (pressure filtration), inlet (suction filtration), or the reservoir return (return line filtration).

The selection of a filter depends on a number of factors including the contaminant ingression rate, the generation of contaminants in the system, the required fluid cleanliness, and the desired maintenance interval. Contaminant ingression rate is determined (among other things) by the type of actuators used in the system. Hydraulic cylinders normally cause higher levels of contamination to enter the system.

Filters are selected to meet these requirements using rating parameters of efficiency and capacity. Filter efficiency may be measured with a Beta ratio[1] (β_x). For suction filtration, with controlled reservoir ingression, a filter with β_{35-45} >= 75 (and β_{10} >= 2) or better has been found to be satisfactory. For return or pressure filtration, filters with an efficiency of β_{15-20} >= 75 (and β_{10} >= 10) are typically required.

Since each system is unique, the filtration requirements for that system will be unique and must be determined by test in each case. Filtration system acceptability should be judged by monitoring of prototypes, evaluation of components, and performance throughout the test program.

See Sauer-Danfoss publications BLN-9887 [697581] and ATI-E 9201 for more information.

(1) Filter β_x ratio is a measure of filter efficiency defined by ISO 4572. It is defined as the ratio of the number of particles greater than a given diameter (“x” in microns) upstream of the filter to the number of these particles downstream of the filter.

4. Servicing

4.1 Conversions

Group 2 is a modular series. In particular, it is easy to make conversions on the pumps, e.g. changing rotation, replacing flange, drive shaft, seals, or assembling a tandem pump from two single pumps. On the following page are tables showing the allowable conversions.

4.1.1 Recommendations

Due to a specific manufacturing process known as **cut-in** — during which the gears, pump body, and bearing blocks are allowed to establish a unique relationship to each other — it is generally not recommended to open and replace components of a gear pump or motor. The removal or replacement of some internal components will unavoidably modify their critical dimensions. Because pumps and motors are cut-in at a specific pressure to ensure maximum efficiency, removal or replacement of internal components may be detrimental to the pump or motor efficiency. Pump / motor conversions are allowed if the following criteria are followed. The following is a list of general recommendations.

- The personnel performing any type of conversion must be trained. The performance of a converted unit is in direct relationship with the quality of the job. A trained, qualified technician, by following the procedures in this manual, should be able to perform a quality job.
- Conversions should be limited to changing the rotation, changing the seal kit, and replacing the flange and rear cover. Changing the gear set is not advisable. When this operation cannot be avoided special care must be taken.
- Whenever possible avoid making conversions to gear motors, as the critical dimensions are more sensitive to minor changes.
- Always use new, factory supplied parts when making a conversion.
- After any conversion, it is recommended that the unit be tested on a suitable test stand in order to confirm its performance.
- Reference the conversion tables given on the next page to ensure the operation is allowed.

4.2 Conversion Tables

The tables on the following page summarize the conversion operations which are allowed. For any unit component, the table shows the possibility of a conversion operation (from one pump to another pump, from one motor to another motor, from pump to motor, and from motor to pump.) For SKP, the only conversion allowed is from pump to pump.

Component	Conversion Operation			
YES = Allowed NO = Not Allowed N.R. = Allowed but not recommended	From Pump to Pump	From Motor to Motor	From Motor to Pump	From Pump to Motor
Body	NO	NO	NO	NO
Bearing	N.R.	NO	NO	NO
Front Flange	YES	YES	NO	NO
Rear Flange (Tandem)	YES	----	----	NO
Cover	YES	YES	NO	NO
Drive Gear	YES	YES	YES	NO
Idle Gear	YES	YES	YES	NO
Pressure Seals	YES	YES	NO	NO
Outer Seal	YES	YES	YES	YES
Shaft Seals	YES	YES	YES	YES
Snap Rings	YES	YES	YES	YES
Dowel Pins	YES	YES	YES	YES
Bolts	YES	YES	YES	YES

T101 135E

The following conversion steps are allowed on the product groups listed below.

Conversion	SNP 2	SNU 2	SEM 2	SNM 2	SKP 2	SHM 2
Rotation	YES	YES	NO	NO	YES	NO
Input Shaft	YES	YES	YES	YES	YES	YES
Rear Cover	YES	NO	NO	NO	YES	NO
Flow Setting	YES	NO	NO	NO	YES	NO
Pressure Setting	YES	NO	NO	NO	YES	NO
Front Flange	YES	YES	YES	YES	YES	YES
Displacement	YES	YES	YES	YES	YES	YES
Mulitple Pumps	YES	NO	NO	NO	YES	NO

T101 136E

5. Disassembly

5.1 General

In the following pages a detailed procedure is given for disassembly and assembly of pumps and motors. Prior to proceeding it may be necessary to prepare some subassemblies separately.

The details for preparing each subassembly are given in the following section.

Also, some general recommendations are given below.

5.1.1 Cleanliness

Cleanliness is a primary factor for reliable pump performance. Wash the outside of the pump thoroughly before disassembly and all pieces prior to assembly. Cleaning parts with clean shop solvent and air drying is usually adequate.

5.1.2 Lubrication of Moving Parts

During assembly, it is imperative to provide lubrication with clean hydraulic oil to all the running parts of the pump.

It is also necessary to coat the seals with grease. The absence of lubrication during assembly can cause the unit to seize after a few minutes of running.

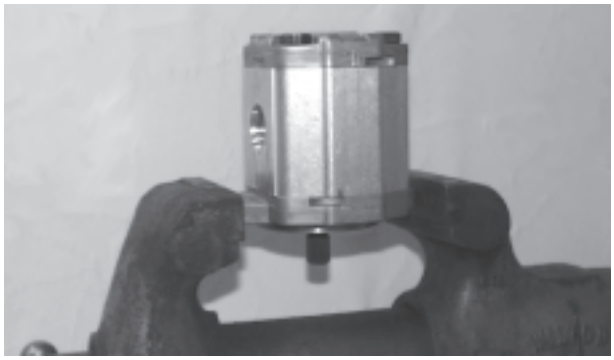
5.1.3 Care of Surface Treatment

Be careful when handling all the internal surfaces, especially bearings, gears, and body faces. Do not touch or score them with metal tools or cutting edges.

5.1.4 Marking the Parts

Mark the parts before completely disassembling a pump. The marks allow components to be reassembled in the same relative position. This action should be applied to the body, bearings, and gears. Scribing, bluing, or using a felt tip pen to mark the outside of the body on the inlet side is suggested to indicate the relative position of the front flange and the rear cover to the body. Mark the bearing blocks also on the inlet side and the gears position relative to each other. **DO NOT** scribe internal surfaces.

5.1.5 Procedure



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1. Clamp the unit.

Clamp the unit in a vice from the flange side.

Make sure the vice jaws are clean and have smooth surfaces to prevent damage to the pump.

Clamping the pump on the body is not recommended because serious damage to the surfaces, on which the ports are located, may occur.

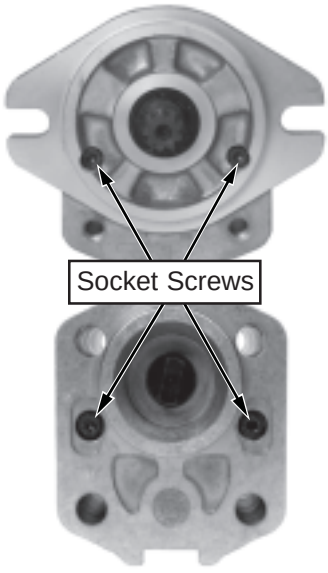
F101 001

2. Remove capscrews.
(Except Units with 03 Flange)

Use a 17 mm socket wrench and loosen the four capscrews on the cover. Next completely unscrew the capscrews and remove them.

Inspect the threads of the capscrews for damage.

06 Flange (first stage of multiple pump)



03 Flange

F101 002

3. Remove socket head capscrews.
(03 Flange or Multiple Pump Stages Only)

Using a 4 mm internal hex wrench, loosen and remove the two small socket screws placed in the center of the cover. Repeat the same operation for the corresponding screws on the rear flange.

4. Remove front flange.

Place the pump on the table and slowly remove the front flange.

Be careful not to damage the shaft seal when removing the flange. Avoid contact of the shaft seal lips with keyway edges (in tapered and parallel shafts) or splined shaft teeth.

Inspect the front flange and seal area.

Clean with shop solvent, dry, and set aside.

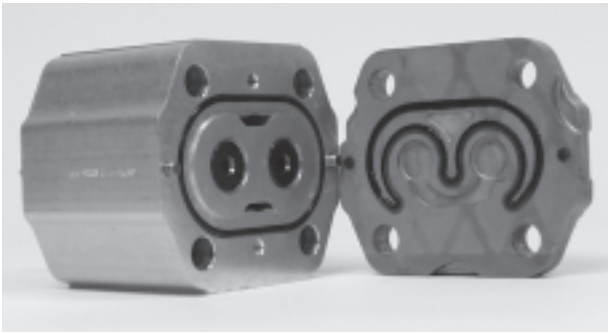
F101 003

5. Remove rear cover.

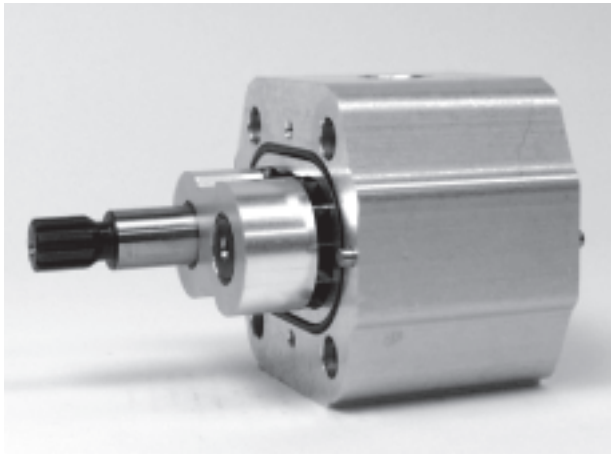
Remover rear cover.

Clean with shop solvent, dry, and set aside.

Visually inspect rear cover and seal area.



F101 004

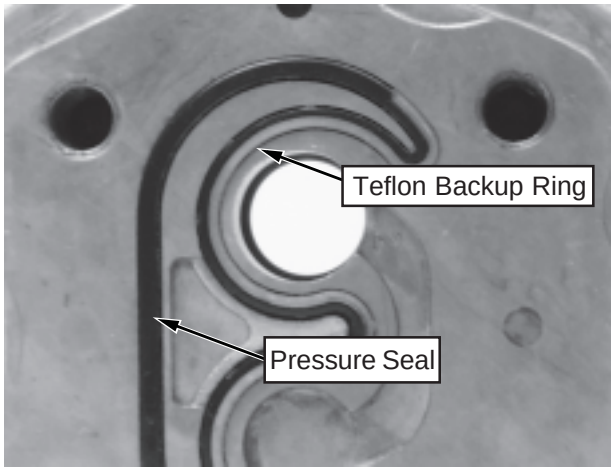


F101 005

6. Remove bearing blocks and gears.

Place the pump on its side and carefully remove the bearing block and gear set. To accomplish this, hold the pump body and push with your fingers on the rear bearing block.

Mark the relative positions of the gear mesh (drive gear tooth to idler gear tooth) and the bearing blocks to the body so they can be reassembled in the same position.



F101 006

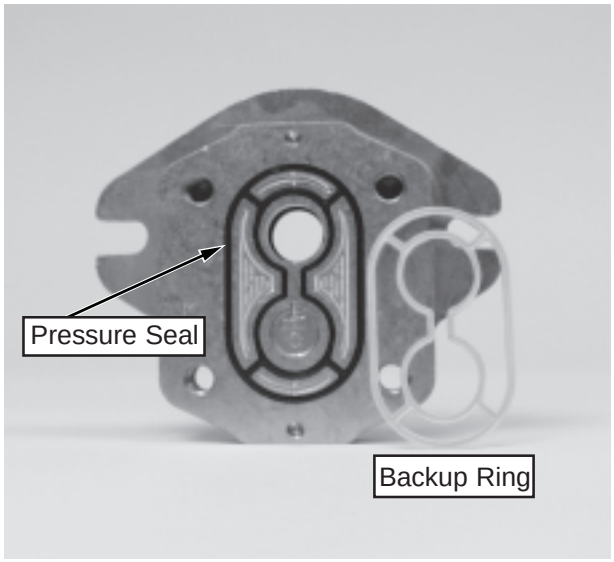
7. Remove pressure seals.

- **For SNP 2/SNU 2/SEP 2/SHP 2**

Check the seal quality. Replacement is recommended whenever there are burrs, evidence of extrusion, or marks caused by overheating. If the seals need to be replaced, carefully remove them from the flange cover, beginning with the backup ring and then the pressure seal.

Important: Do not use tools with sharp edges to remove the seals, as damage to the cover can result.

After removal, dispose of damaged seals.



F101 007

- **For SNM 2/SEM 2/SHM 2/SNR 2 Motors**

Follow the same recommendations given for the previous item. If it is necessary to remove the seals, pay close attention to this procedure. Do not force the removal of the backup ring, remove it gradually to avoid damaging the groove in the flange.

The pressure seal is very delicate, handle it with care.

After removal, dispose of damaged seals.

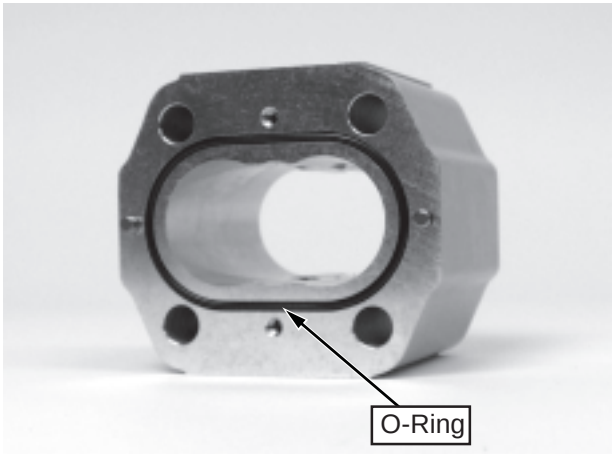
Important: Do not use tools with sharp edges to remove the seals, as damage to the cover can result.

8. Remove Outer O-Ring Seal

Check the quality of this seal. If necessary, replace it. Follow the same removal recommendations given in step 7.

After removal, discard the damaged seal.

Important: Do not use tools with sharp edges to remove the seals, as damage to the cover can result.



F101 008

9. Remove the snap ring.

Place the flange on the work surface. Using internal snap ring pliers, remove the snap ring.

F101 009

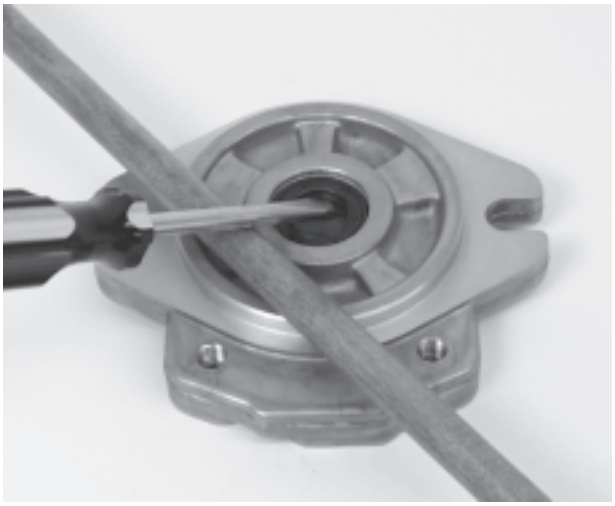
10. Remove the shaft seal.

Check the shaft seal quality and remove if necessary.

To remove, pry the bottom of the shaft seal and force it out while rotating the flange to lift it out evenly.

Do not use the flange pilot to gain leverage, damage may result. Use a plastic rod or wooden dowel as a fulcrum.

After removal, dispose of damaged seal.



F101 010

6. Assembly

F101 011

1. Prepare the seals.

Have the entire seal kit available.

Lightly coat all seals with seal grease. The grease is needed to adhere the seals to their grooves.

Do not install dry seals.

F101 012

2. Install shaft seal into front flange.

Prepare the flange and shaft seal by lightly lubricating with grease.

Seat the seal in the flange by hand. Then, using the shaft seal installation tool (*shown on page 52)*, press the seal until the tool stops on the flange. This will insure the seal is inserted to the proper depth.

F101 013

3. Install snap ring.

Install the snap ring using internal snap ring pliers. Ensure the snap ring fits securely in its groove. This is necessary to retain the shaft seal.

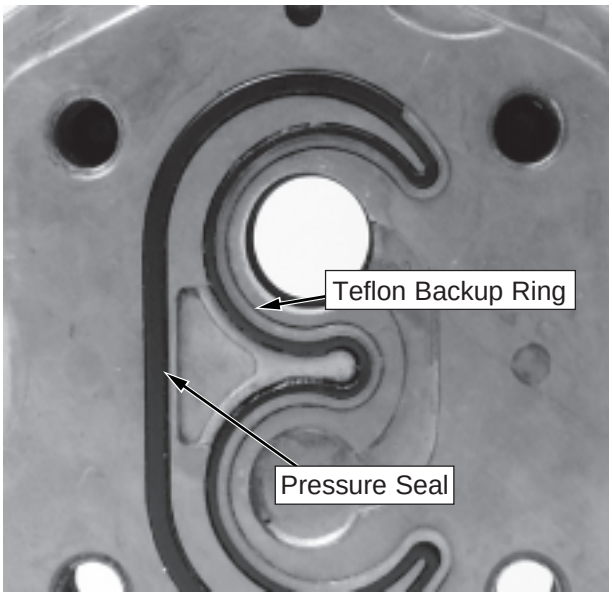
4. Install pressure seals.

- Pumps and Uni-Directional Motors

Prepare the pressure seals by lightly lubricating them with grease.

Install pressure seals into the grooves on the front flange and rear cover. Then install the teflon backup ring.

Ensure that the seals are located in the grooves, as shown.



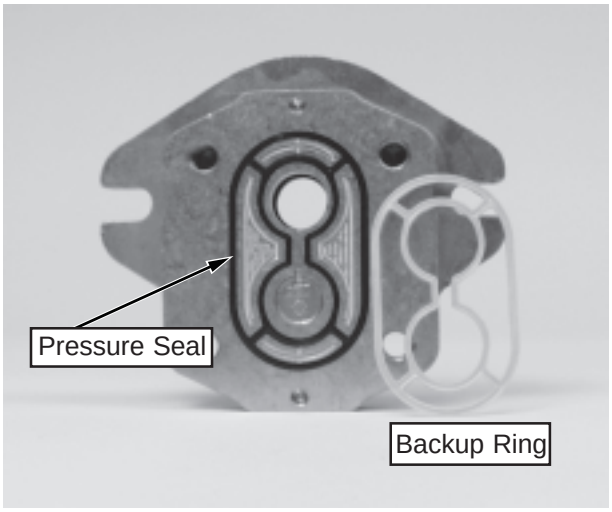
F101 014

- **Bi-Directional Motors**

Prepare pressure seals by lightly lubricating them with grease.

Install pressure seals into the grooves on the front flange and rear cover. Then install the teflon backup ring.

The backup ring will fit tightly into the groove. Work the backup ring into the groove by hand. Begin with the internal portion of the seal, then proceed outward until the backup ring is securely pressed into place.

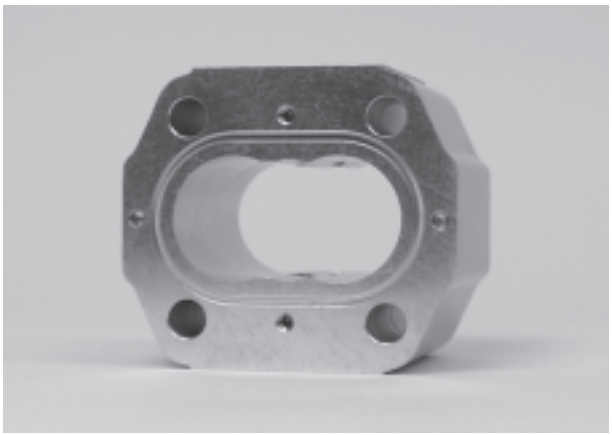


F101 007

5. Prepare the body.

Clean the body.

Inspect the internal and mating surfaces. Ensure the surfaces are free of burrs and scratches. Check both the bearing block mating surface and the cut-in path. The cut-in path should be no deeper than 0.1 mm (0.004 in).



F101 016

F101 017

6. Install outer seal.

Prepare the outer seal by lightly lubricating with grease.

Install outer seals in the grooves on both sides of the body.

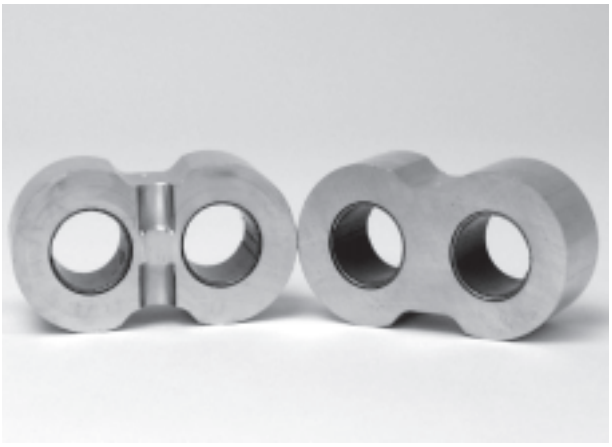
F101 018

7. Prepare the gears.

Caution: The gear surfaces are superfinished. Residue on hands and fingers may be corrosive to this surface. **Do not touch**.

Carefully clean the two gears. If the gears are new, wash them with shop solvent to remove any anticorrosive grease on the surfaces.

Inspect the journals and the flat faces on the top and bottom of the gears. Ensure these surfaces are free from burrs or scratches. If scratches or burrs are found, clean them with a flat stone and/or very fine emery paper. Rewash the gears after this operation.



F101 019

8. Prepare the bearing blocks.

Clean the two bearing blocks.

Inspect the flat surfaces of the bearing blocks for burrs or scratches on the edges. If necessary, remove burrs with very fine emery paper. Then rewash the bearings.

Inspect the DU™ bushings for wear. There should be no bronze showing.

Using clean hydraulic oil, lubricate the internal and external surfaces of the bearing blocks.

9. Assemble the bearing blocks and gears.

Lubricate the journals and the gear faces.

Assemble the bearing blocks and gears. Ensure that the recessed bearing faces are installed adjacent to the gear faces. Align all assembly marks made during disassembly. Ensure the front and rear bearing blocks occupy the same location with respect to the housing as before disassembly. Ensure that the relative position of the gear mesh is maintained as before disassembly. Misalignment of the gear teeth may increase operating noise.

F101 020

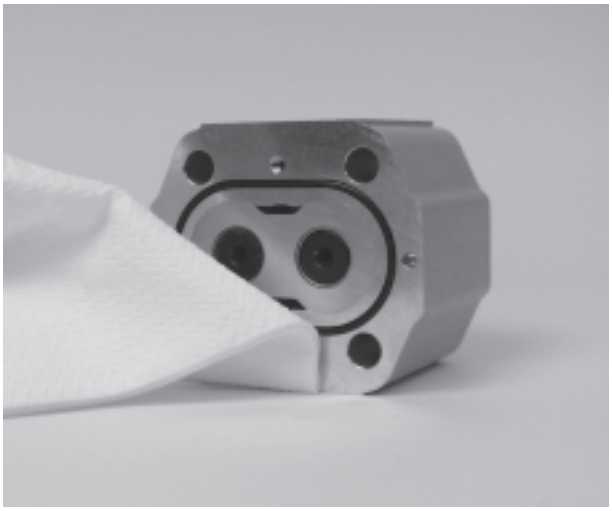
10. Install the gear block assembly.

Install the bearing block and gear assembly into the body cavity. Align the assembly marks to ensure that the gear block assembly is installed with the same orientation as before disassembly.

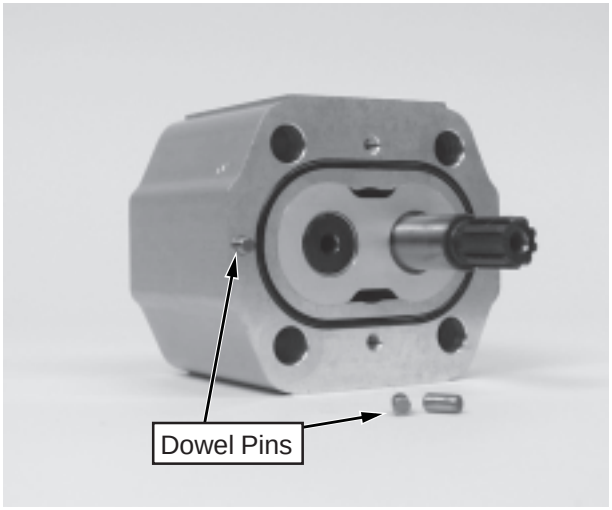
F101 022

11. Clean the mating surfaces.

Remove any excess lubrication and grease from the mating surfaces of the pump body. Ensure that these surfaces are dry and free of contamination before moving on to the next step.



F101 023

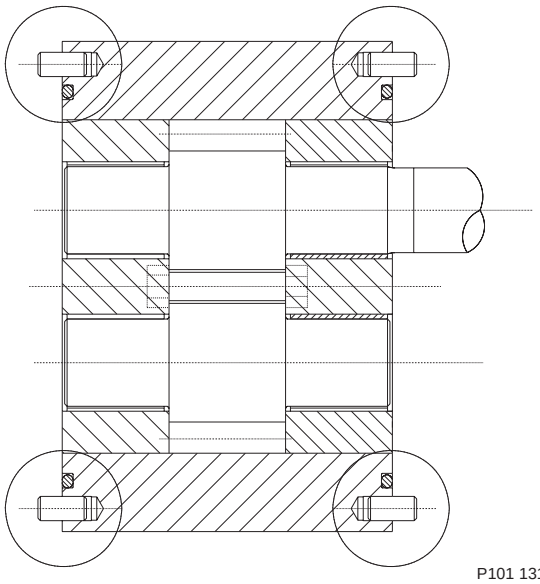


F101 024

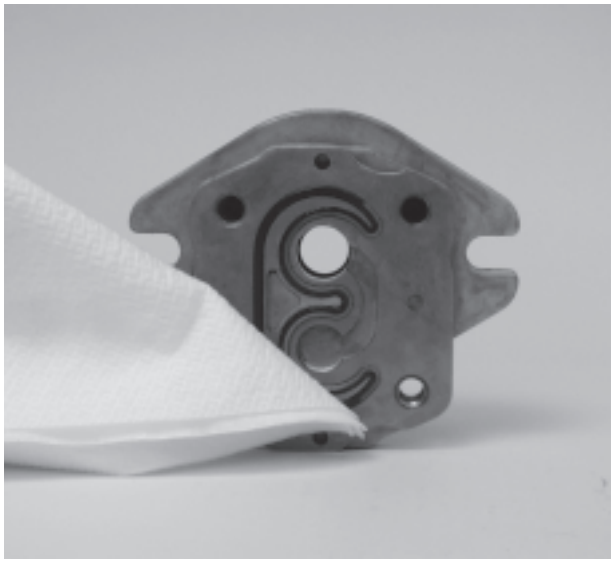
12. Install the dowel pins.

Install four 5 mm dowel pins into the proper cavities on both sides of the body (refer to the illustration). Swab the pins with assembly grease or petroleum jelly to retain them during assembly.

Do not install dowel pins to the rear cover or flange, as one of them may drop inside the pump during assembly.



P101 131



F101 025

13. Clean the mating surfaces.

Remove any excess lubrication and grease from the mating surfaces of the front flange and rear cover. Ensure that these surfaces are dry and free of contamination before moving on to the next step.

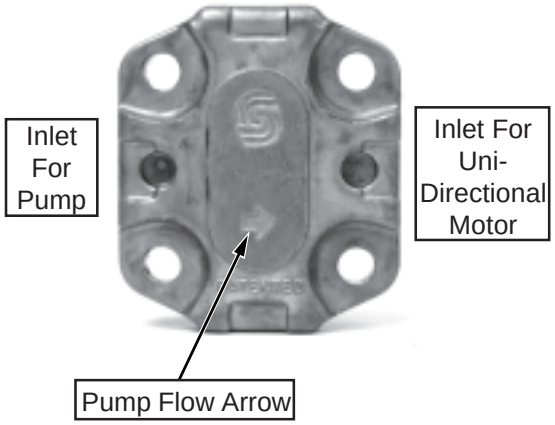
Ensure the pressure seals are seated properly after this operation.

14. Install Rear Cover.

Mount the cover on the body. Ensure the arrow on the back is oriented properly. The arrow should be:

- In the same direction as the flow if the unit is a pump.
- Against the direction of the flow if the unit is a unidirectional motor.
- If the unit is a bidirectional motor the arrow does not appear on the cover.

Ensure that all the pressure seals stay in place during this operation.



F101 026

15. Prepare pump for front flange assembly.

Place the pump with the rear cover downwards.

Ensure that the assembly marks on the bearing block / body are properly aligned.

F101 027

16. Install the front flange.

Install a protective sleeve over the shaft. The sleeve is used to protect the shaft seal from damage by the shaft splines / keyway during front flange assembly.

Install the flange onto the body, then remove the protective sleeve.

Ensure that the seals remain seated in their grooves during this operation.

F101 028

F101 029

17. Torque sequence. (all except 03 type)

Note: When assembling units with 01 flange and short coupled tandems, wash the capscrews and apply Loctite® 242 or equivalent thread lock compound to the threads before assembly.

Install capscrews. While observing the torque sequence shown, pre tighten the capscrews. Then, using a torque wrench, tighten them to the proper torque.

Torque 44-54 Nm (32-40 lbf•ft).

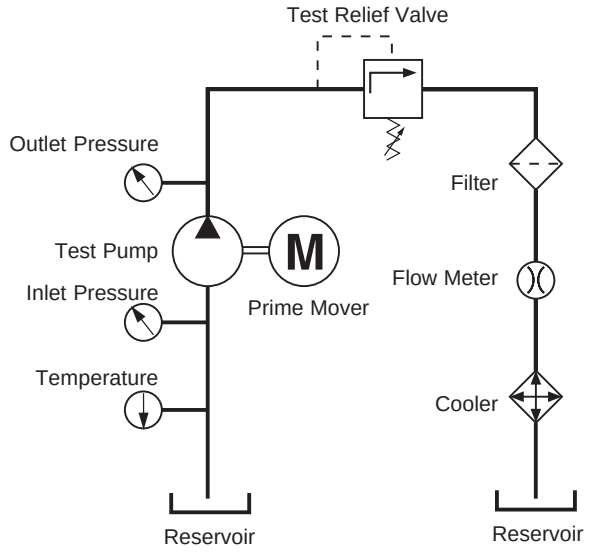
F101 030

18. Install socket head capscrews. (03 flange and first stage of multiple)

Using a 4 mm internal hex wrench, install the socket head capscrews to the front flange and rear cover.

Torque 2.5-3.4 Nm (22-30 lbf•in).

If used, install new o-ring to flange pilot.



P101 132

19. Testing

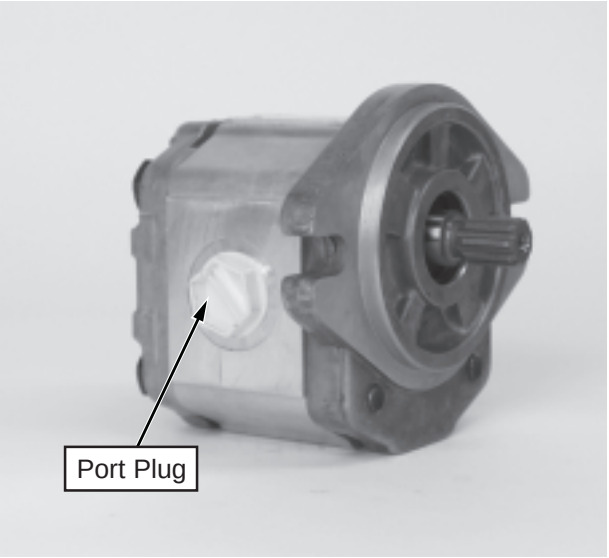
After pump has been disassembled and reassembled, it is suggested that the pump be run in and tested on an appropriate test stand. This is done to verify the volumetric efficiency and the integrity of the unit.

Test specifications and procedure are given in section 11.3.

20. Prepare the unit for shipment or storage.

Clean the exterior of the pump and install the following:

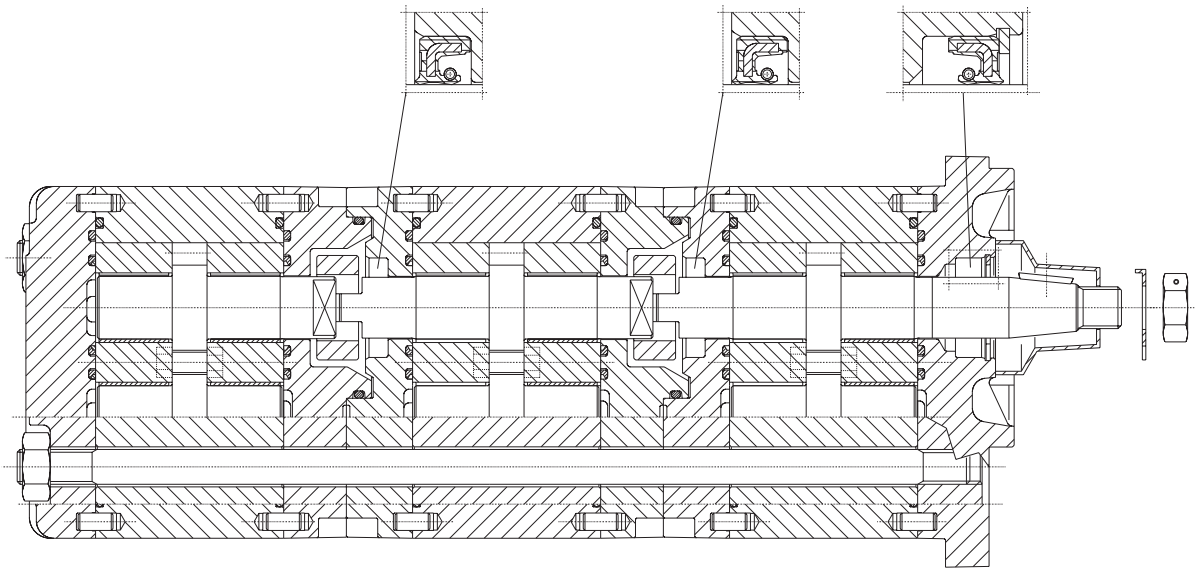
- Port Plugs
- Key (CI and CO shafts)
- Shaft protective cap (CI and CO shafts)
- Nut and washer (CO shaft)



F101 031

7. Multi Stage Pumps

7.1 General



P101 133

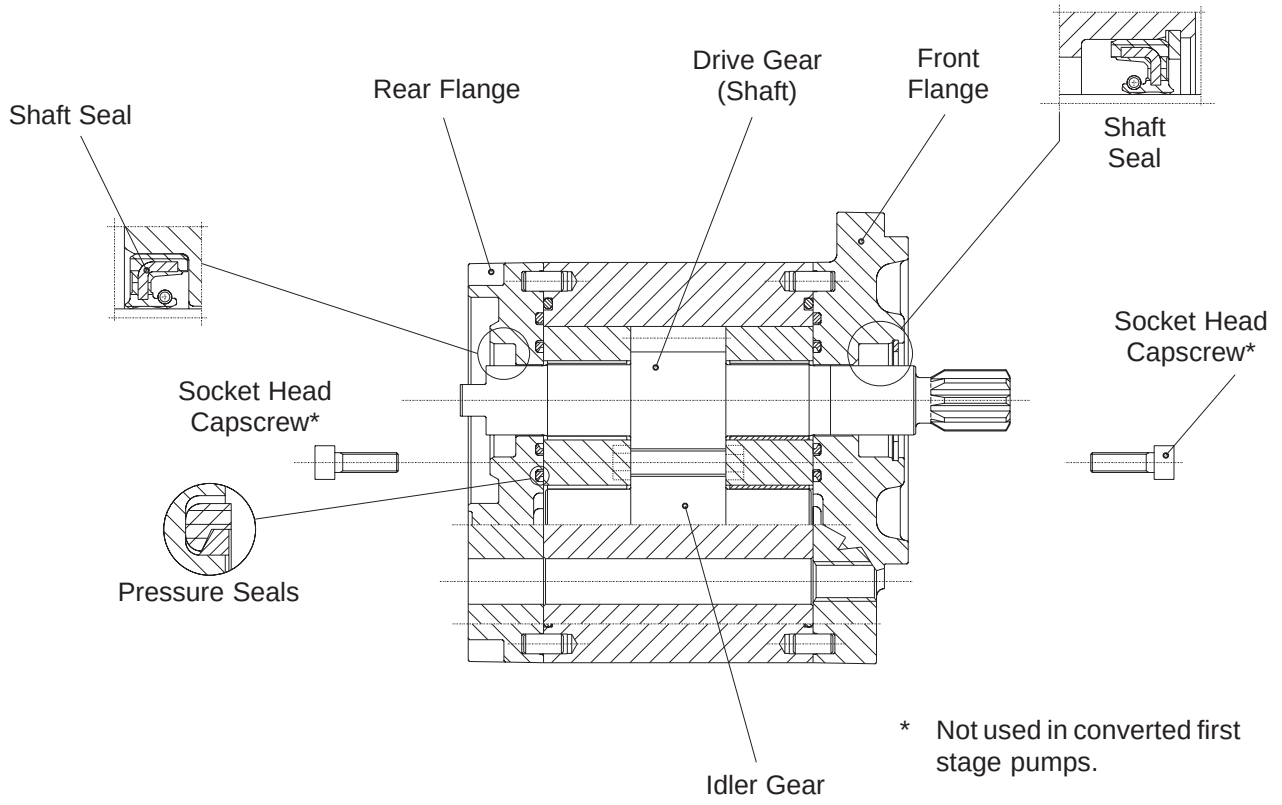
7.1.1 Construction

Multiple stage pumps may be purchased directly from Sauer Danfoss, or individual stages can be purchased and assembled. Single pumps can also be converted to multiple stages by replacing the drive gear (shaft) and front or rear flange. Other multiple configurations can be achieved by mixing pumps of different groups, however this manual will present information regarding multiple pumps configured strictly from the group 2 product line.

Intermediate stages are of the FR43 or FR73 type, and final stage is of the FR03 type. A tang output shaft and oldham style coupling connect each stage. Since the coupling requires lubrication from the pump inlet, the front shaft seal is omitted on all pumps except the first stage.

Socket head capscrews retain the front flange and rear cover of each stage. The assembly is held together by hex nuts and studs extending from the rear cover of the final stage to the front flange of the first stage. Studs will differ in length depending upon the displacement combination of all pumps in the unit. *A table of stud lengths for tandems and a formula for calculating stud length of multiples can be found in the appendix, section 11.2.*

7.2 First Stage Pump Preparation



P101 134

7.2.1 General

The figure above shows a cross section of a typical group 2 first stage pump. A first stage pump can be purchased directly from the factory or it can be made from a single stage pump.

First stage pumps supplied from the factory are pre-assembled with two socket head cap screws on the front flange, and two in the rear flange. When a first stage pump is converted from a single pump, the socket head capscrews are omitted. The front and rear flanges will then be retained by the main capscrews (or studs) of the assembled multiple pump.

7.2.2 Model Code

The model code for ordering a first stage pump is:

SNP2/..yy4x

Where:

'yy' is the shaft type (CO/CI/SC/FR)

'x' is the flange type

See: Model Code, pages 8 and 9.

7.2.3 Converting a Single Stage Pump to a First Stage Pump

To prepare a first stage unit from a single pump, following components are required:

- Single pump having the same configuration (flange and porting) as the desired first stage pump.
- Drive gear (shaft) for the first stage pump.
- Rear flange of the correct rotation.
- Rear shaft seal.

A first stage pump when converted from a single pump, will not require the small socket head capscrews as shown in the figure. The front flange will be retained by the four main capscrews (or studs) of the multi stage pump.

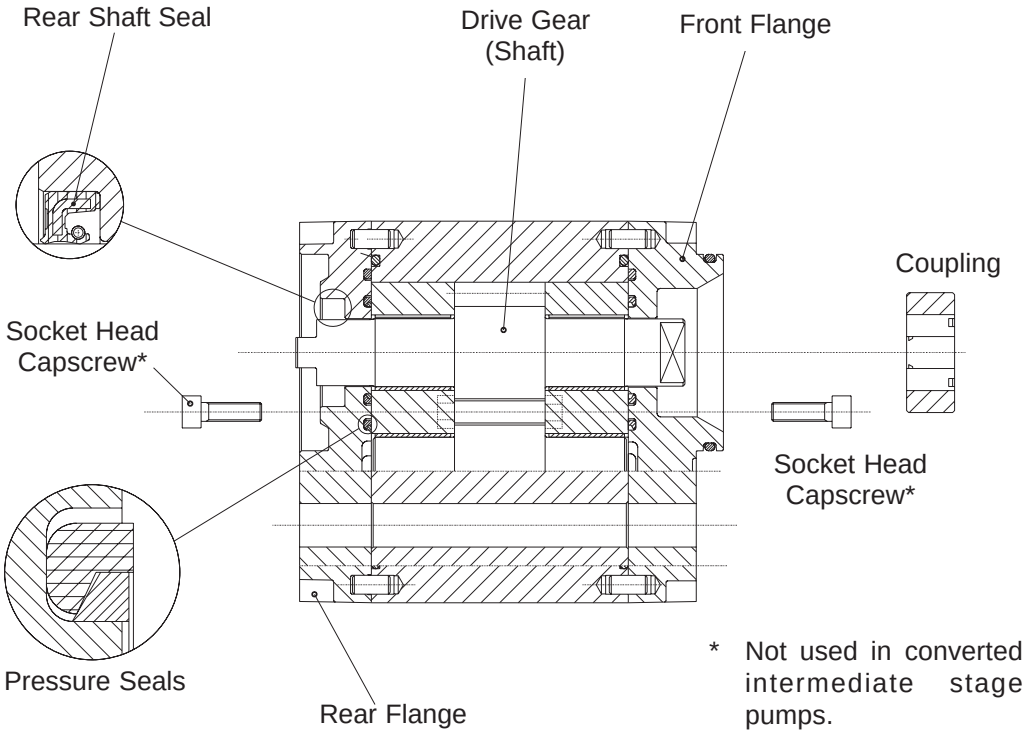
7.2.4 Conversion Procedure

The instructions given here show the unique steps involved when converting pumps. In addition to these, follow the assembly and disassembly instructions in sections 5 and 6.

1. Open the pump, remove the flange, rear cover, and gear block.
2. Replace the existing drive gear (shaft) with the appropriate new shaft.
3. Lubricate shaft seal with grease and install into the seal cavity of the rear flange. Snap ring is not required to retain the rear shaft seal.
4. Lubricate the pressure seals with grease and install into the rear flange.
5. Using assembly grease to retain them, install the dowel pins to the pump body.
6. Install the rear flange. Ensure the rear flange has the correct direction of rotation.
7. Using a protective sleeve on the shaft, install the front flange.

The first stage pump is now ready to be assembled with the other stages.

7.3 Intermediate Stage Pump Preparation



P101 135

7.3.1 General

The figure above shows a cross section of a typical group 2 intermediate stage pump. An intermediate stage pump can be purchased directly from the factory, or it can be made from a single stage pump.

Intermediate stage pumps supplied from the factory are pre-assembled with two socket head cap screws on the front flange, and two in the rear flange. When an intermediate stage pump is converted from a single stage pump, the socket head capscrews are omitted. The front and rear flanges will then be retained by the main studs of the assembled multiple pump.

7.3.2 Model Code

The model code for ordering an intermediate stage pump is:

SNP2/...FR73....x

Where:

'x' is the type of porting required as expressed in the table at the right.

See: Model Code, page 8 and 9.

X	Porting
B	Flanged port with threaded holes in "X" patern (German standard ports), centered on the body
C	Flanged port with threaded holes in "+" patern (European standard ports)
E	Threaded SAE o-ring boss ports
F	Threaded Gas port (BSPP)
G	Flanged port with threaded holes in "X" patern (German standard ports), offset from center of body

T101 137E

7.3.3 Converting a Single Stage Pump to an Intermediate Stage Pump

To prepare an intermediate stage pump from a single stage pump, the following components are required:

- SNP2/...FR03 type pump with the desired porting and rotation.
- Drive gear (shaft) for intermediate stage pump.
- Rear flange of the appropriate rotation.
- Rear shaft seal.

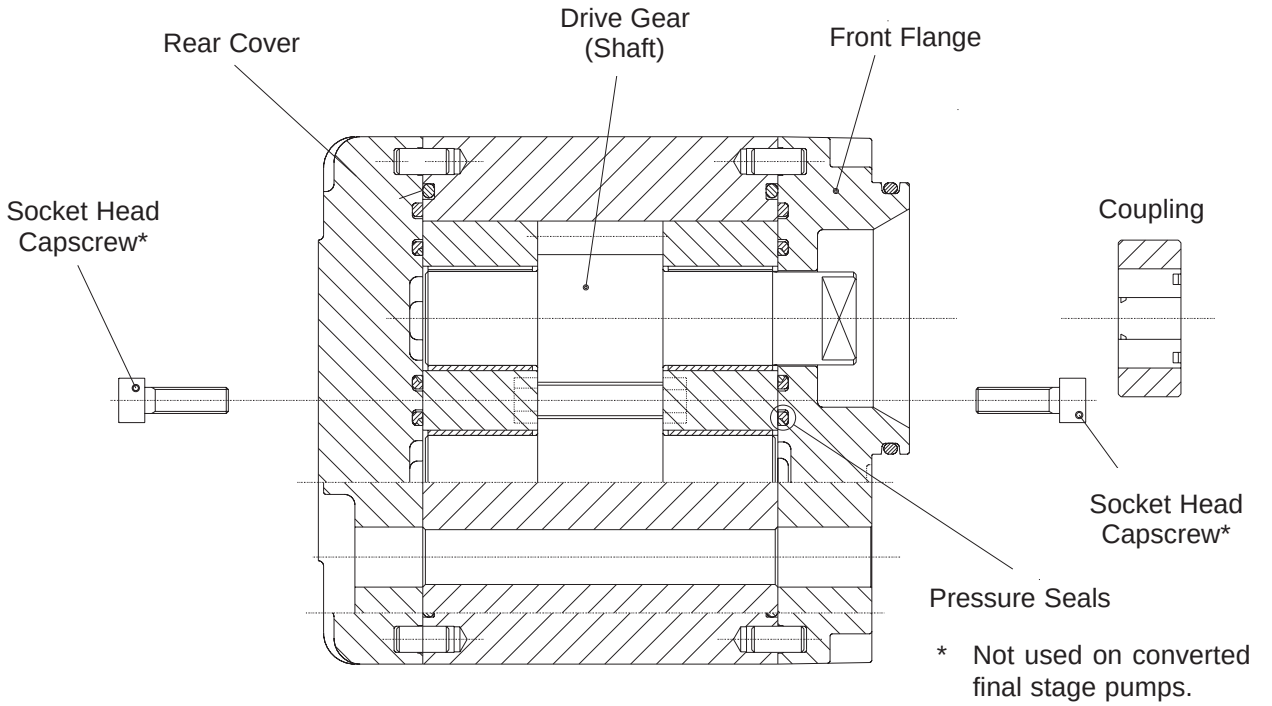
7.3.4 Conversion Procedure

The instructions given here show the unique steps involved when converting pumps. In addition to these, follow the assembly and disassembly instructions in sections 5 and 6.

1. Remove the capscrews, rear cover, and drive gear (shaft).
2. Replace the drive gear (shaft) with the intermediate pump drive gear.
3. Lubricate the rear shaft seal with grease and install it into the seal cavity of the rear flange. Snap ring is not required to retain the rear shaft seal.
4. Lubricate the pressure seals with grease and install into the rear flange.
5. Using assembly grease to retain them, install the dowel pins to the pump body.
6. Install the rear flange onto the pump body.

The intermediate stage pump is now ready to be assembled with the other stages.

7.4 Final Stage Pump Preparation



P101 136

7.4.1 General

The figure above shows a cross section of a typical FR03 type pump. Even though this pump is a standard single stage pump, it is commonly used as a final stage pump. This pump can be purchased directly from the factory, or it can be made from a single stage pump.

Final stage pumps supplied from the factory are pre-assembled with two socket head cap screws on the front flange, and two in the rear cover. When an intermediate stage pump is converted from a single stage pump, the socket head capscrews are omitted. The front and rear flanges will then be retained by the main studs of the assembled multiple pump.

7.4.2 Model Code

The model code for ordering a final stage pump is:

SNP2/...FR03....x

Where:

'x' is the type of porting required as expressed in the table at the right.

See: Model Code, pages 8 and 9.

X	Porting
B	Flanged port with threaded holes in "X" patern (German standard ports), centered on the body
C	Flanged port with threaded holes in "+" patern (European standard ports)
E	Threaded SAE o-ring boss ports
F	Threaded Gas port (BSPP)
G	Flanged port with threaded holes in "X" patern (German standard ports), offset from center of body

T101 137E

7.4.3 Converting to a Rear Stage Pump

To prepare a final stage pump from a single stage pump, the following components are required:

- SNP2 single stage pump with the desired porting and rotation.
- Final stage drive gear (shaft).
- 03 or 73 type front flange of the appropriate rotation.

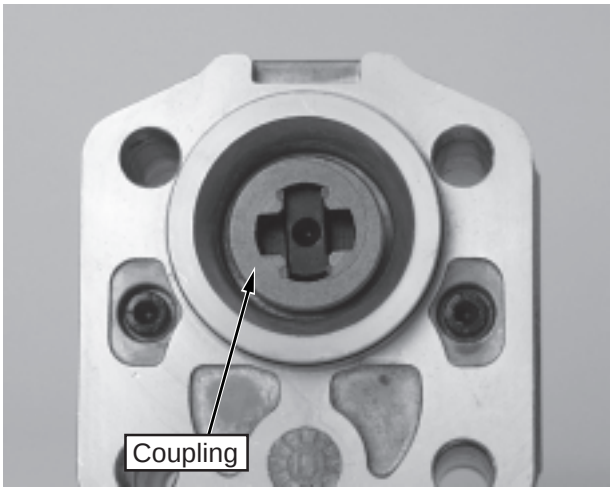
7.4.4 Conversion Procedure

The instructions given here show the unique steps involved when converting pumps. In addition to these, follow the assembly and disassembly instructions in sections 5 and 6.

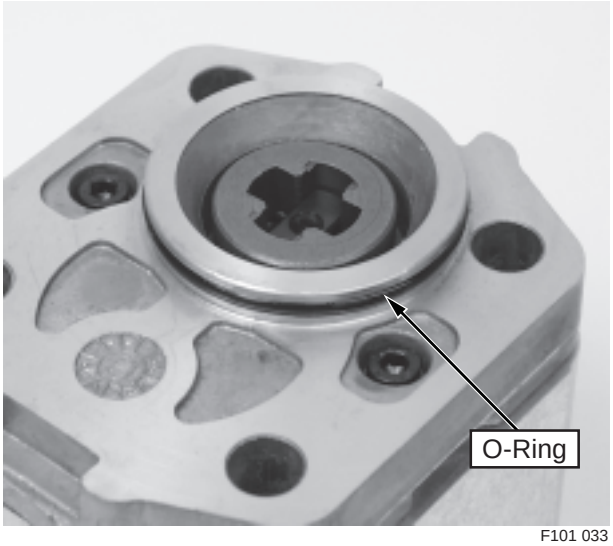
1. Remove the front flange and drive gear (shaft) from the pump.
2. Replace the drive gear (shaft) with a final stage drive gear.
3. Lubricate the pressure seals with grease and install them to the front flange. No shaft seal is required on the final stage pump.
4. Using assembly grease to retain them, install the dowel pins to the pump body.
5. Install the front flange onto the pump. Ensure that the flange has the appropriate direction of rotation.

The final stage pump is now ready to be assembled with the other stages.

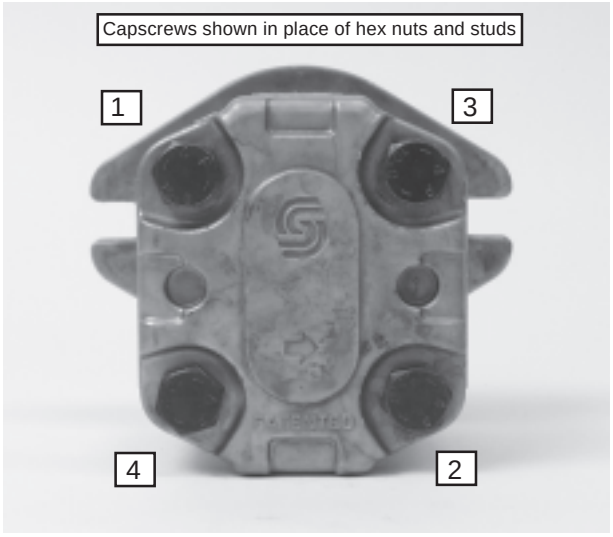
7.5 Assembly of Multi-Stage Pumps



F101 030



F101 033



F101 029

1. Install the coupling.

Place the first stage pump on the work bench, so that the rear flange is in the upward position.

If necessary, remove burrs on the flange. Blow the surface and cavity of the flange with compressed air to remove any debris before assembly.

Fit the coupling onto the rear tang of the shaft.

2. Install studs and torque.

Clamp the first stage of the pump in a vice on the front flange side. Install the studs.

Torque to 5-10 Nm (4-7 lbf•ft).

Stud length tables and guidelines are found in the appendix, sections 11.1 and 11.2.

3. Assemble the stages.

If necessary, remove burrs from the front flange of the second stage pump, then clean with compressed air.

Lubricate the pilot and o-ring with grease.

Mount the second stage pump onto the rear pad of the first stage. Align the tang of the shaft with the coupling. The two tangs must be rotated 90° from each other. The coupling will not engage the shaft if it is not properly aligned. Press units together until the pilot is fully engaged.

Repeat this operation for every pump stage.

4. Install and torque hex nuts.

Install the hex nuts.

Torque to 50-60 Nm (37-44 lbf•ft).

Use the torque sequence shown at the left.

Test and prepare the pump for shipment or storage *as shown in steps 19 and 20 on pages 25 and 26.*

7.6 Change of Rotation

7.6.1 General

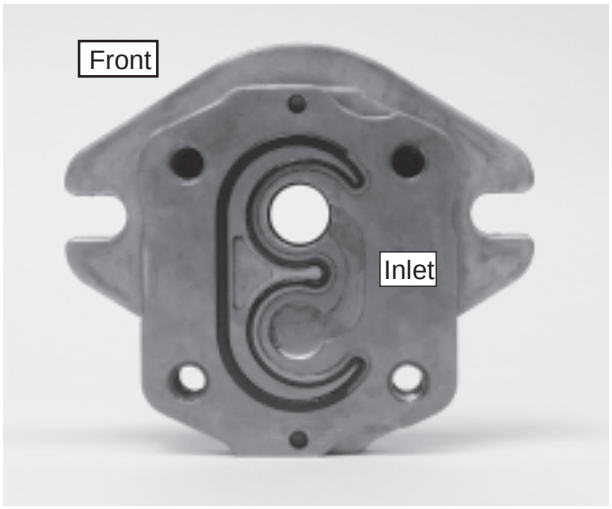
The SNP2 pumps are designed with the pressure seals located in grooves on the rear cover and front flange. Therefore the front flange must be replaced whenever a changing rotation. The front flange of a pump is 'oriented' for a particular direction of rotation.

Rear covers, except in multiple configurations, may be rotated 180° to be used in either direction of rotation.

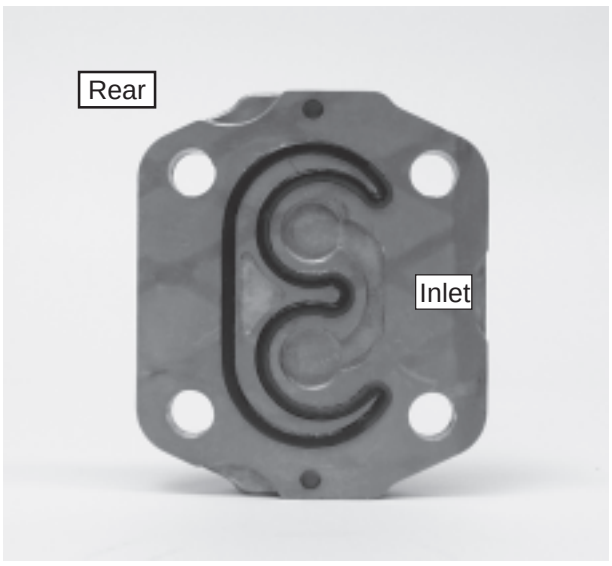
7.6.2 Determining the Direction of Rotation

The direction of rotation of a given flange can be determined by referencing its part number in the appropriate parts list. Direction of rotation can also be determined by the appearance of the flange. Compare to the photographs shown on this page. The seal groove encloses the high pressure area or outlet of the pump (inlet of unidirectional motors). When observed from the inside (looking at the sealed surface), the high pressure area will be on the left side in clockwise pumps, and on the right side for anti-clockwise rotating pumps.

Clockwise Rotation

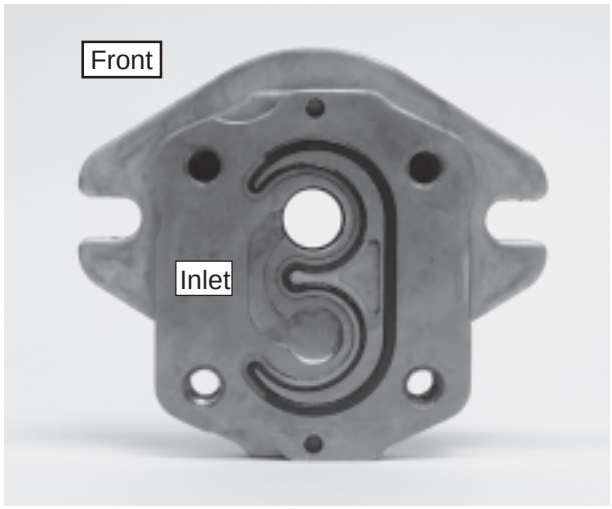


F101 035

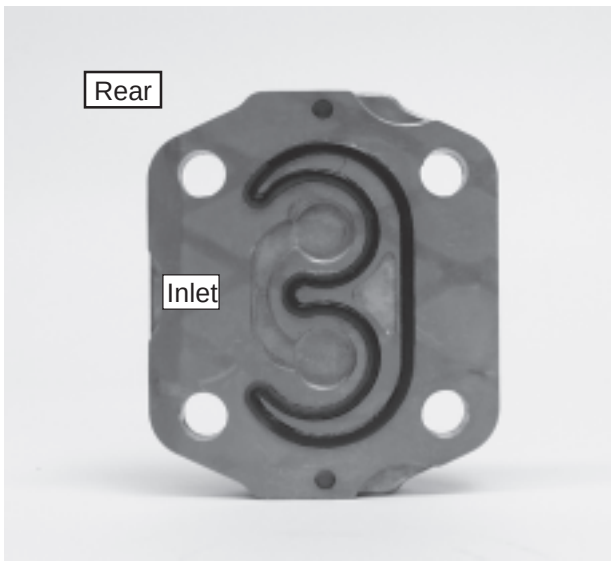


F101 036

Anti-Clockwise Rotation



F101 037



F101 038

7.6.3 Model code

Rotation is expressed in the model code as follows:

SNP2/...x....

Where '**x**' is:

D = Clockwise, right hand rotation.

S = Anti-clockwise, left hand rotation.

7.6.4 Conversion procedure

To change rotation of a pump, the following components are required:

- A front flange of the appropriate direction of rotation.
- A rear cover if converting a multistage pump.

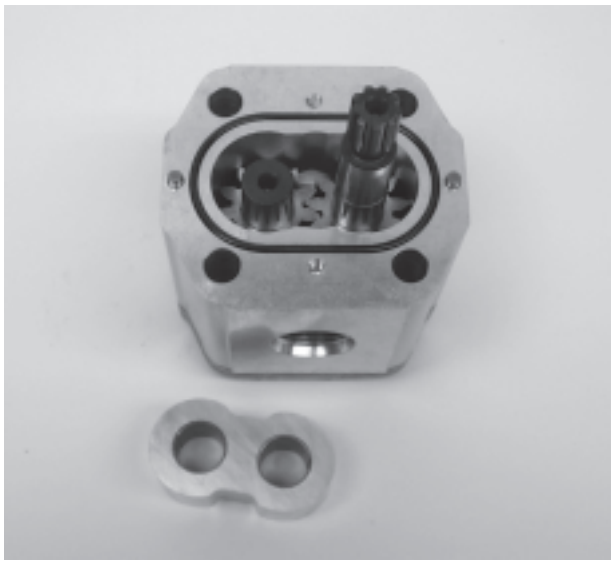
The instructions given here show the unique steps involved when converting pumps. In addition to these, follow the assembly and disassembly instructions in sections 5 and 6.

F101 039

1. Remove front flange.

Remove the capscrews and place the pump on the work bench with the rear cover down. Remove the front flange.

Mark the position of the front bearing block for reassembly.



F101 040

2. Remove bearing block and drive gear / shaft.

Remove the front bearing block.

Mark the relative position of the gear teeth for reassembly.

Remove the drive gear / shaft.

2. Remove idler gear.

Remove the idler gear from the body cavity, leaving the rear bearing block in place.

F101 041

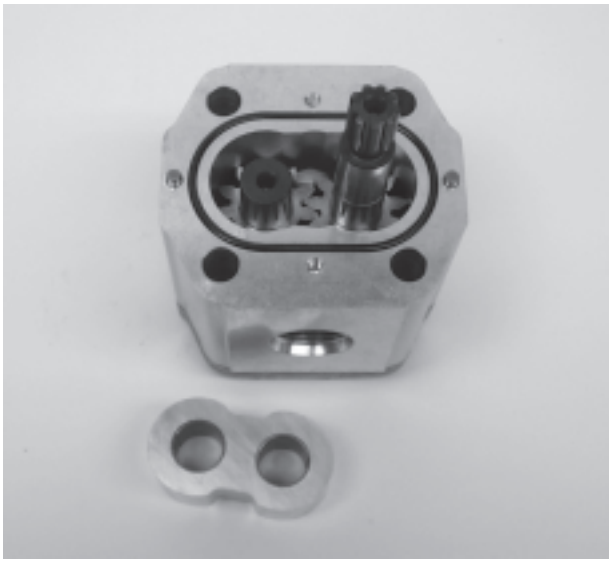
3. Move idler gear.

Install the idler gear into the opposite position in the bearing block.

F101 042

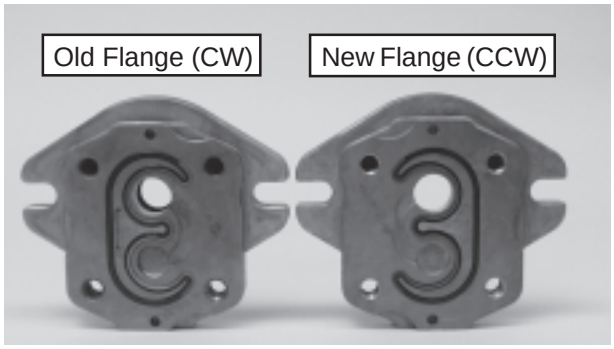
4. Reinstall the drive gear / shaft.

Reinstall the drive gear / shaft. Align the gear teeth to the assembly marks.



F101 040

F101 043



F101 044

5. Install front bearing block.

Install the front bearing block into the body cavity. Align the assembly marks.

6. Install the new front flange.

Install the seals and assemble the new front flange onto the pump body.

Note: Follow step 7 only if converting the first or an intermediate stage of a multiple pump. If converting a single pump or the final stage of a multiple pump skip step 7.

7. Multiple pumps only, change the rear flange.

Turn the pump over and remove the rear flange.

Install new pressure seals and shaft seal to the new rear flange.

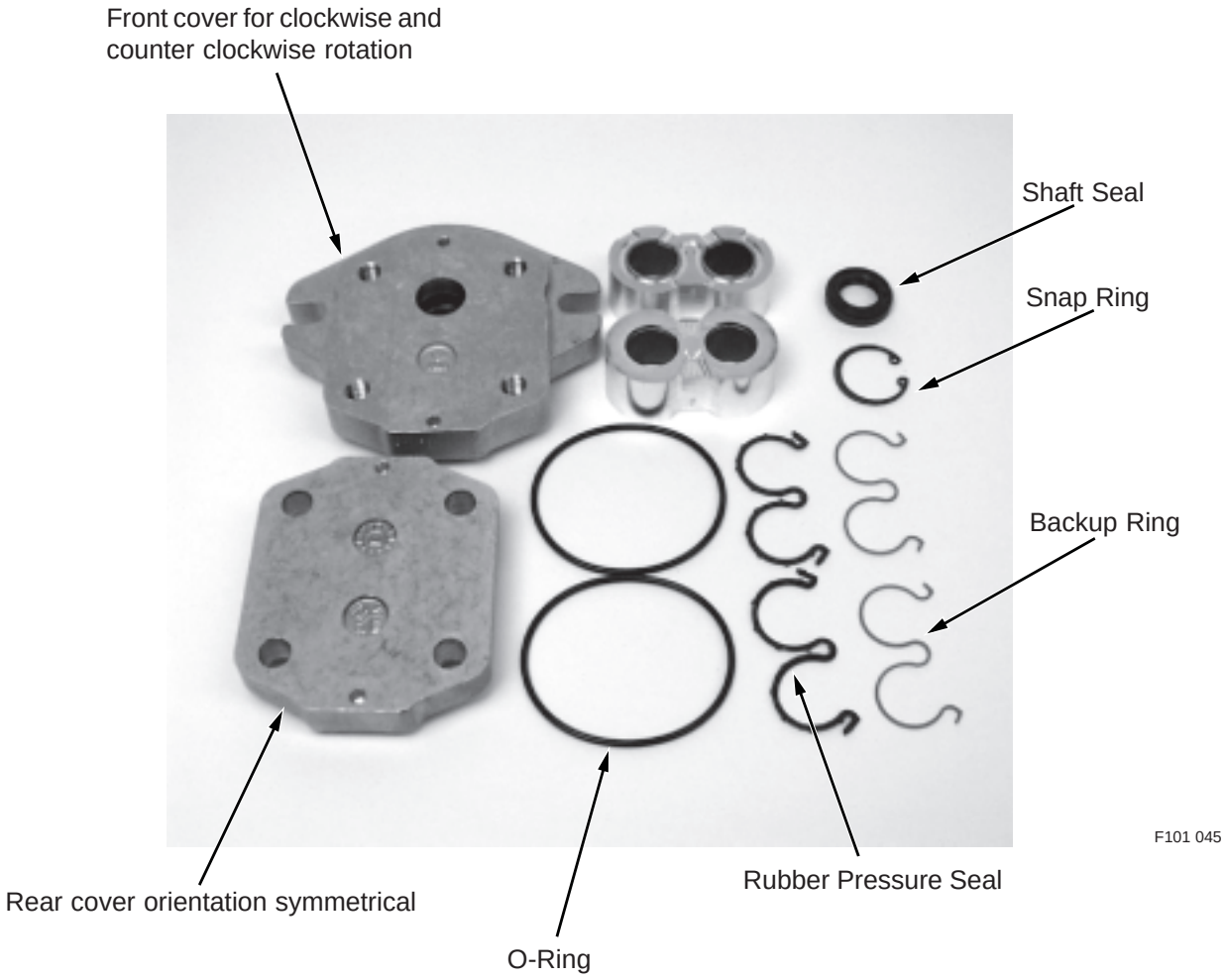
Install the new rear flange to the pump body.

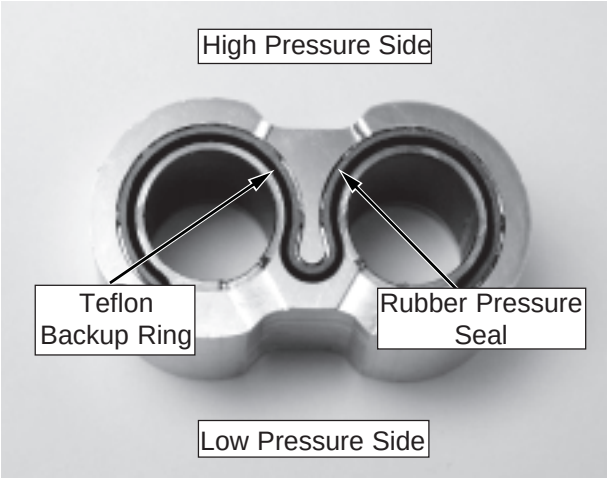
8. SKP2 Pumps

8.1 General Information

SKP2 Pumps are designed to accommodate an 11 tooth SAE splined shaft for higher torque applications.

The differences between SKP2 and SNP2 pumps are described in this section.





F101 046

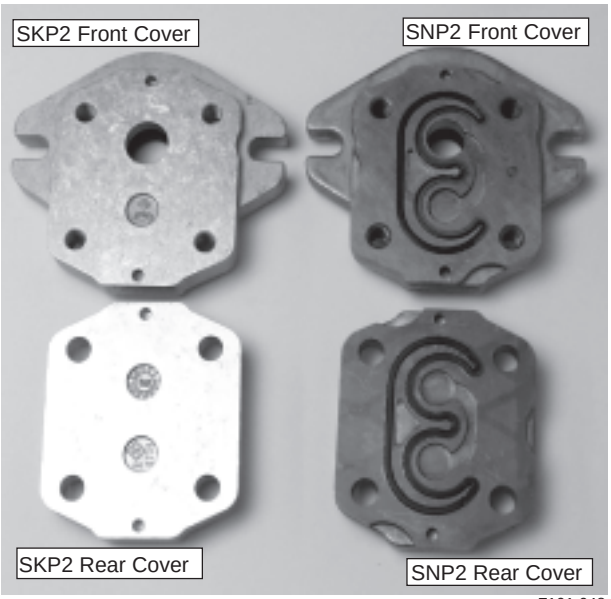
8.1.1 Bearing Block For SKP2

In SKP2 pumps, the pressure seals are located on the bearing blocks as shown.

F101 047

8.1.2 Drive Gear Shaft Differences

The shaft on the drive gear for the SKP2 is larger than the shaft on the drive gear for the SNP2. The journal diameters of the SKP2 shaft are 20 mm [.787 in], while the shaft of the SNP2 is 18 mm [.708 in].



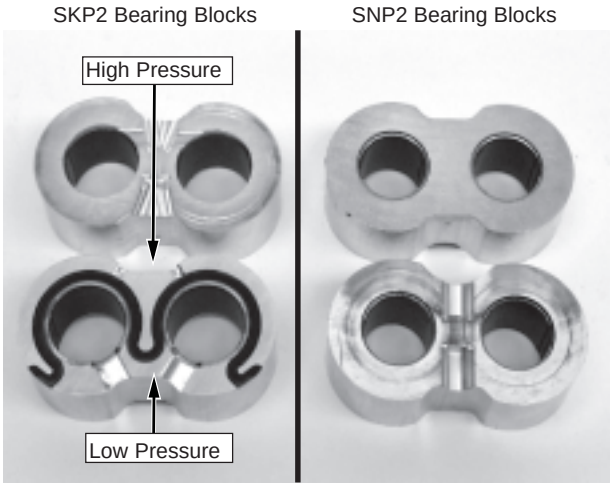
F101 048

8.1.3 Front and Rear Flange Differences

In the SKP2, the front and rear cover can be utilized for both clockwise and counter clockwise rotation. With the SKP2, it is not necessary to change the front and rear cover when changing the direction of rotation. With the SNP2, you must change the front cover and rotate the rear cover when changing the direction of rotation.

8.1.4 Bearing Block Differences

In the SKP2, the pressure seal and backup ring are mounted in grooves on the bearing blocks, while in the SNP2, the pressure seal and backup ring are mounted in grooves on the front flange and rear cover. In the SKP2, the bearing blocks must be installed with the correct orientation to the high and low pressure sides. The bearing blocks for the SNP2 are symmetrical with respect to the high and low pressure sides.



F101 049

8.2 Changing the Rotation of SKP2

F101 050

F101 051

F101 052

There is no additional hardware required to change the rotation on an SKP2 pump.

The instructions given here show the unique steps involved when converting pumps. In addition to these, follow the assembly and disassembly instructions in sections 5 and 6.

1. Remove drive gear and front bearing block.

Remove the capscrews and place the pump on the work bench with the rear cover down. Remove the front flange.

Remove the drive gear / shaft and front bearing block only. Hold a finger on the idler gear hole to keep it in place while removing the drive gear / shaft and bearing block.

Mark the position of the front bearing block relative to the body. Also, mark the position of the mating gear teeth relative to each other.

2. Remove idler gear.

Remove the idler gear from the body, leaving the rear bearing block in place.

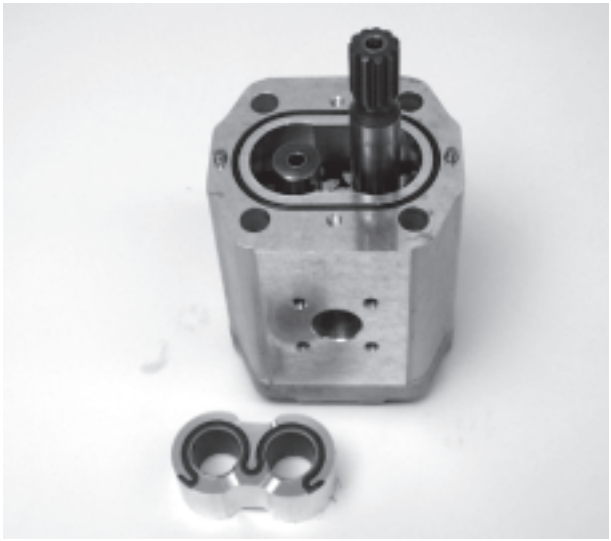
3. Install idler gear into the opposite position.

The idler gear, that was just removed, must now be installed into the other side of the body cavity.

4. Install the drive gear / shaft.

Reinstall the drive gear into the free side of the body cavity.

Align the assembly marks on the gear teeth.



F101 053

5. Install the front bearing block.

Install the front bearing block into the body.

Align the assembly marks on the bearing block and body..

F101 054

6. Install the front flange.

Rotate 180° and re-Install the front flange.

F101 055

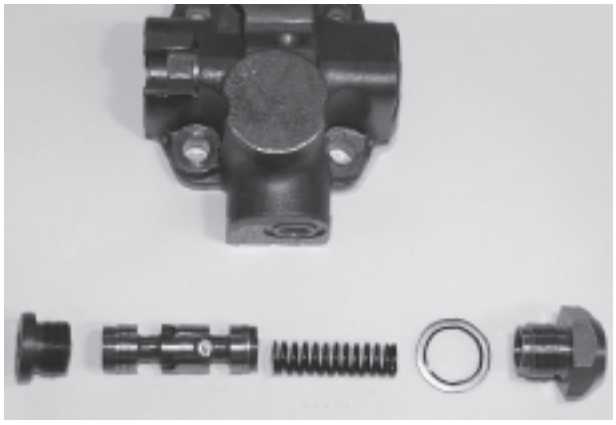
9. Product Options

9.1 Rear Cover with Integral Priority Flow Divider Valve

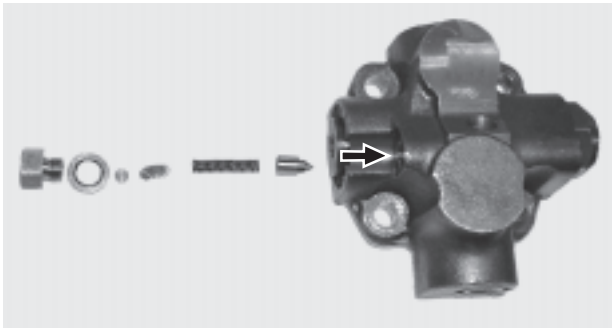
9.1.1 General Information

Group 2 pumps are offered with an optional priority flow divider valve integrated into the rear cover. Flow and pressure settings are made at the factory and are not adjustable.

When necessary, flow divider covers may be disassembled for cleaning and inspection only.



F101 056



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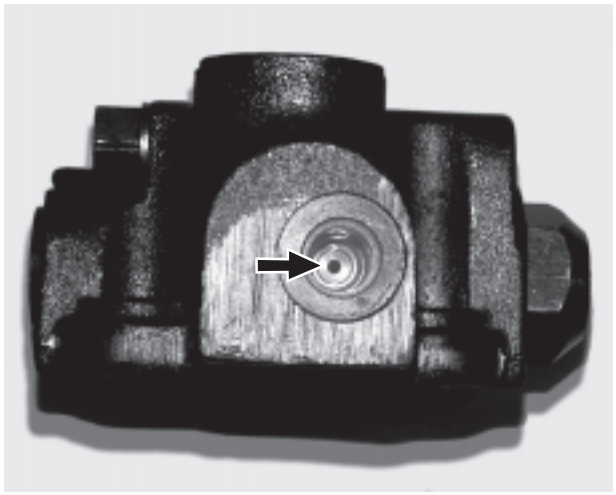


F101 058

9.1.2 Disassembly and Reassembly

1. Remove the capscrews and rear cover.

Remove the capscrews holding the pump together. Remove the rear cover and set aside.

2. Remove the flow control spool assembly.

Remove the caps at each end of the spool. Remove the dowty washer from the spring end cad. Remove the spool and spring.

3. Remove the pilot relief valve.

Remove the cap, dowty washer, shims, spring, and plunger from the cavity.

Caution: Shims are required to set the relief pressure. Retain **all** shims for reassembly.

4. Inspect flow control orifice.

Check the flow control orifice (located in the priority flow port) for debris or obstruction. Clean as necessary.

Caution: The flow control orifice is press fit at the factory. **Do not attempt to remove it.**

5. Inspect, clean, and reassemble.

Inspect components for damage. Clean and remove any debris from parts and cavities. Reassembly is the reverse of above.

9.2 Rear Cover with Integral Relief Valve

9.2.1 General Information

Group 2 pumps are offered with an optional adjustable relief valve integrated into the rear cover.

When necessary, the relief valve may be disassembled for cleaning and inspection.

9.2.2 Disassembly and Reassembly

1. Remove the relief valve assembly.

Using a 24 mm hex wrench, remove the relief valve cartridge from the rear cover, remove the washer, spring, spring seat, and poppet from the cavity.

2. Inspect, clean, and reassemble.

Inspect the poppet and mating seat in the housing for damage. Clean and remove any debris from parts and cavity. Reassemble in reverse order of disassembly.

Torque relief valve cartridge to 47 Nm (35 lbf • ft).

3. Check and reset relief valve pressure.

Using an appropriate test stand, check and if necessary, reset the relief valve to the proper pressure setting.

The adjustable relief has 4 setting ranges. The outside of the valve housing will be stamped with a number as follows:

- “0” has a range from 3-25 bar (43.5-363 psi).
- “1” has a range from 26-40 bar (377-580 psi).
- “2” has a range from 41-150 bar (595-2175 psi).
- “3” has a range from 151-250 bar (2190-3625 psi).

Turn the adjustment screw clockwise to increase pressure, anti-clockwise to reduce.

Refer to the appendix, section 11.3, for information on testing pumps.

F101 059

10. Trouble Shooting

10.1 Low or No Flow From Gear Pump

Item	Description	Action
1. Check oil level in reservoir.	Insufficient oil to supply gear pump.	Fill reservoir to proper level.
2. Check input spline condition.	Input shaft broken or stripped.	Repair or replace gear pump.
3. Check pressure at pump inlet. *Recommended inlet pressure: 0.8 to 3.0 bar absolute. 0.6 Minimum at cold start.*	Clogged suction filter or inlet screen.	Replace filter or clean suction screen.
4. Check condition of gear faces and bearing blocks.	Scored bearing block and gear faces will reduce pump efficiency.	Repair or replace gear pump.
5. Check bushings.	Overpressure of gear pump will cause idler gear bushing to fail.	Repair or replace gear pump.

10.2 Excessive Noise

Item	Description	Action
1. Check oil level in reservoir.	Excessive air will cause cavitation sound.	Fill reservoir to proper level
2. Check inlet line for leaks.	Excessive air will cause cavitation sound.	Repair inlet line.
3. Check pressure at pump inlet. *Recommended inlet pressure: 0.8 to 3.0 bar absolute. 0.6 Minimum at cold start.*	Lower than normal inlet pressure causes excessive pump noise.	Return inlet pressure to recommended levels.

10.3 External Leakage

Item	Description	Action
1. Check for pinched o-rings or backup ring seal.	Pinched seal will allow leakage.	Replace pinched seal.
2. Check pressure seals.	Damage to pressure seals is typically caused by reduced “stack-up” in the pump assembly. This may be due to under-torqued assembly fasteners, or more commonly is attributed to excessive wear on the bearing blocks. Reduced “stack-up” will affect seal efficiency possibly to the point of seal extrusion.	Inspect condition of bearing blocks. If they are found to be worn, repair or replace the pump. If bearing blocks are not worn, replace pressure seals and re-torque pump assembly fasteners.

Notes

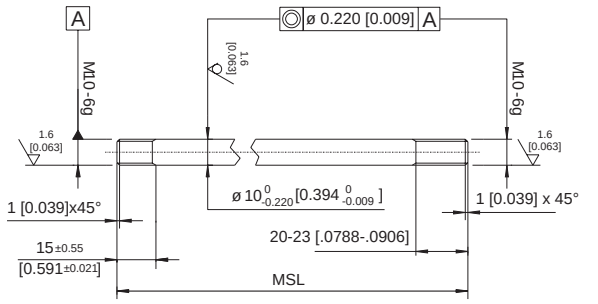
11. Appendix

11.1 Stud Specifications

Studs used to assemble multiple pumps must comply with the following specifications.

- Type Stud
- Thread Dimension ISO M10
- Design Standard DIN 931
- Strength Class (minimum) 10.9
- Surface Treatment Blued

mm [in]



P101 137

MSL = Maximum Stud Length *(see section 11.2 below)*

11.2 Stud Length For Multi-Stage Pumps

11.2.1 Tandem Pumps

The table contains a list of stud lengths for any tandem combination of SNP2 pumps.

Front Disp.	Rear Displacement (type)								
	4	6	8	11	14	17	19	22	25
4	180	183.5	187.5	191.5	197.5	201.5	205.5	211.5	215.5
6	183.5	187	191	195	201	205	209	215	219
8	187.5	191	195	199	205	209	213	219	223
11	191.5	195	199	203	209	213	217	223	227
14	197.5	201	205	209	215	219	223	229	233
17	201.5	205	209	213	219	223	227	233	237
19	205.5	209	213	217	223	227	231	237	241
22	211.5	215	219	223	229	233	237	243	247
25	215.5	219	223	227	233	237	241	247	251

T101 139E

The stud length tolerance is +0 to -0.5 mm [+0 to -0.02 in].

Note: The data given in the tables does not include SHP2 pumps which are longer than SNP2. *See section 11.2.2.*

11.2.2 Multi-Stage Pumps (General Rule)

The following is a general rule that explains how to calculate the stud length for any multiple combination of the SNP2 / SEP2 pump series. This calculation is essentially the combined length of all components in the stack, plus 14mm [0.55 in] to account for minimum thread engagement.

Stud length calculated in this manner has a tolerance of +0 to -0.5mm [+0 -0.02 in].

Given as a formula:

MSL = TBL + TRFL + TFFL + RCL + 14mm [0.55 in]

Where:

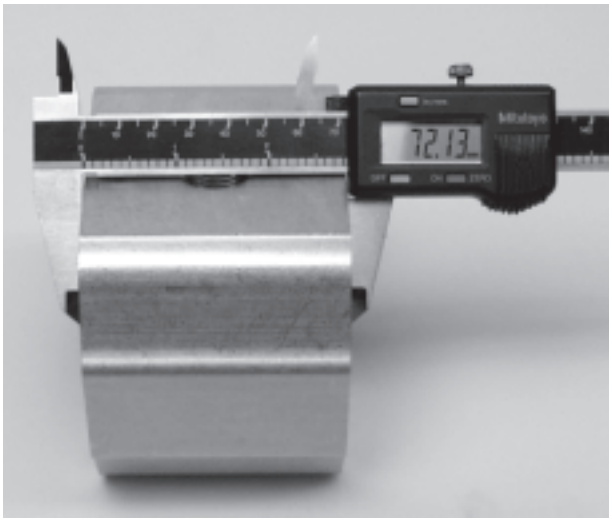
MSL = **M**aximum **S**tud **L**ength
TBL = **T**otal **L**ength of all **B**odies
TRFL = **T**otal **L**ength of all intermediate **R**ear **F**langes
TFFL = **T**otal **L**ength of all intermediate **F**ront **F**langes
RCL = **L**ength of **R**ear **C**over
(from the sealing surface to the nut's spotface)

11.2.3 Component Lengths

Typical values for component lengths are found in the following tables. If the components you are using are not included, measure.

BODY (SNP/SEP/SKP 2)	Length	
	mm	[in]
SNP 2 / 4	50.5	[1.988]
SNP 2 / 6	54	[2.126]
SNP 2 / 8	58	[2.283]
SNP 2 / 11	62	[2.441]
SNP 2 / 14	68	[2.677]
SNP 2 / 17	72	[2.835]
SNP 2 / 19	76	[2.992]
SNP 2 / 22	82	[3.228]
SNP 2 / 25	86	[3.386]

T101 140E



F101 060

Item	Length	
	mm	[in]
Intermediate rear flang	19	[0.748]
Intermediate front flange	18	[0.709]
Cover (mounting face to nut spotface)	13	[0.512]

T101 141E

11.3 Testing the Pumps and Motors

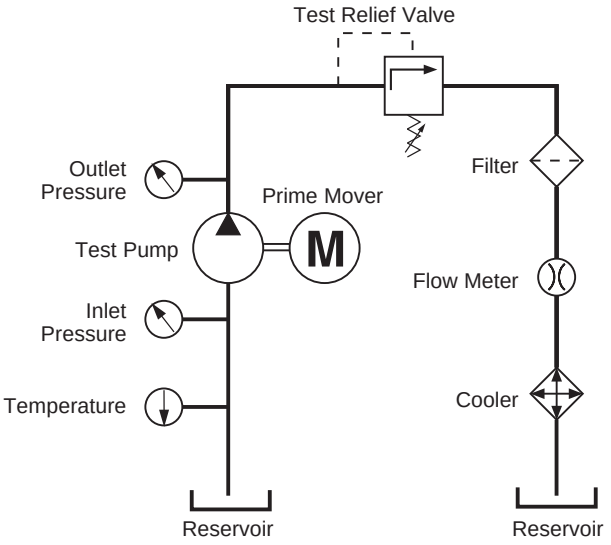
11.3.1 General

After assembling a pump, it should be tested to verify that volumetric efficiency is sufficient to insure satisfactory performance.

Motors can be tested as pumps. Bi-directional motors should be tested in both directions of rotation. Flow rate at drain of motor should be monitored during test.

In order to test a pump, it must be operated on an appropriate test apparatus. Schematic diagram for a typical test apparatus is shown in the figure at the right. Ensure that the test apparatus has sufficient power available to meet the demand of the pump under test (*see specifications, page 10*).

The output flow should meet or exceed the specified value given in the table. If the pump does not pass test, it is necessary to disassemble the pump and find the cause. *Refer to Section 10, Troubleshooting, (page 46) for more information.* It may be necessary to check some dimensions and replace either incorrect, damaged, or worn parts.



P101 132

11.3.2 Test Procedure

Set up the pump on the test apparatus with suitable shaft couplings and port adaptors. Use appropriate fluid per ISO VG468. Start the prime mover and run the pump until the oil temperature is 40° to 45°C [104° to 113°F] as measured in the inlet line.

Set up the following test parameters:

- Pump Speed — 1500 rpm
- Inlet Vacuum — 0.15 bar [2.175 psi]
- Outlet Pressure — See Table

Run the pump for one minute at the pressure noted in the table and check the output flow at the flow meter. For motors, check the flow at the drain as well. If the pump is in good condition, the measured flow rates will meet limits given in the flow limits table.

11.3.3 Tables

Pump Flow Limits Table

Type	Minimum Output Flow	
	l/min	[US gal/min]
4	5.6	[1.48]
6	8.6	[2.27]
8	12.1	[3.20]
11	15.5	[4.09]
14	20.7	[5.47]
17	24.3	[6.42]
19	27.8	[7.34]
22	33.0	[8.72]
25	36.5	[9.64]

T101 142E

11.3.3 Tables (cont.)

Motor Flow Limits Table				
Type	Minimum Output Flow		Maximum Drain Flow	
	l/min	[US gal/min]	l/min	[US gal/min]
6*	8.6	[2.27]	0.30	[0.079]
8	12.0	[3.17]	0.30	[0.079]
11	15.5	[4.09]	0.35	[0.092]
14	20.6	[5.44]	0.40	[0.105]
17	24.1	[6.37]	0.40	[0.105]
19	27.6	[7.29]	0.40	[0.105]
22	33.0	[8.72]	0.40	[0.105]
25	36.5	[9.64]	0.40	[0.105]

T101 143E

Test Pressure Table (Pumps)								
Type	SEP 2		SNP 2		SKP 2		SHP 2	
	bar	[psi]	bar	[psi]	bar	[psi]	bar	[psi]
4	225	[3265]	250	[3625]	250	[3625]	N.A.	N.A.
6	225	[3265]	250	[3625]	250	[3625]	N.A.	N.A.
8	225	[3265]	250	[3625]	250	[3625]	N.A.	N.A.
11	225	[3265]	250	[3625]	250	[3625]	N.A.	N.A.
14	180	[2611]	250	[3625]	250	[3625]	N.A.	N.A.
17	180	[2611]	250	[3625]	250	[3625]	N.A.	N.A.
19	N.A.	N.A.	210	[3045]	240	[3481]	240	[3481]
22	N.A.	N.A.	180	[2610]	210	[3045]	210	[3045]
25	N.A.	N.A.	160	[2320]	190	[2756]	190	[2756]

T101 144E

Test Pressure Table (Motors)								
Type	SEM 2		SNM 2		SNU 2		SHM 2	
	bar	[psi]	bar	[psi]	bar	[psi]	bar	[psi]
6*	210	[3045]	230	[3335]	-	-	-	-
8	210	[3045]	230	[3335]	250	[3626]	-	-
11	210	[3045]	230	[3335]	250	[3626]	-	-
14	210	[3045]	230	[3335]	250	[3626]	-	-
17	210	[3045]	220	[3190]	230	[3335]	-	-
19	180	[2610]	210	[3045]	210	[3045]	240	[3481]
22	160	[2320]	180	[2610]	180	[2610]	210	[3045]
25	140	[2030]	160	[2320]	160	[2320]	190	[2756]

T101 145E

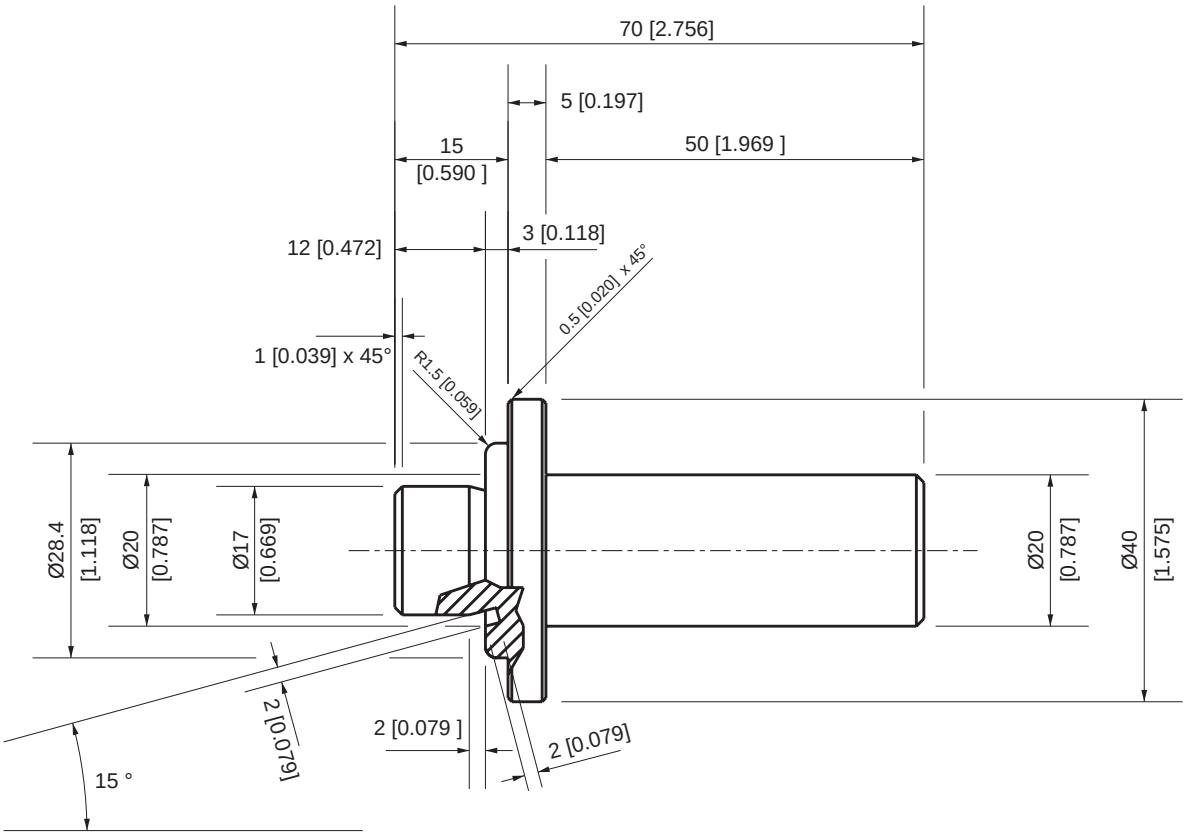
* In addition to the prescribed test procedure, it is recommended that the 6cc motor be tested also as a motor. This can be done in the application by providing flow to the motor inlet to with no torque on the shaft at start-up. Motor will be considered to have passed this test if it performs satisfactorily under the application's normal load.

11.4 Tools

mm [in]

This section contains drawings useful in fabricating any specialized tools required to service group 2 gear pumps and motors.

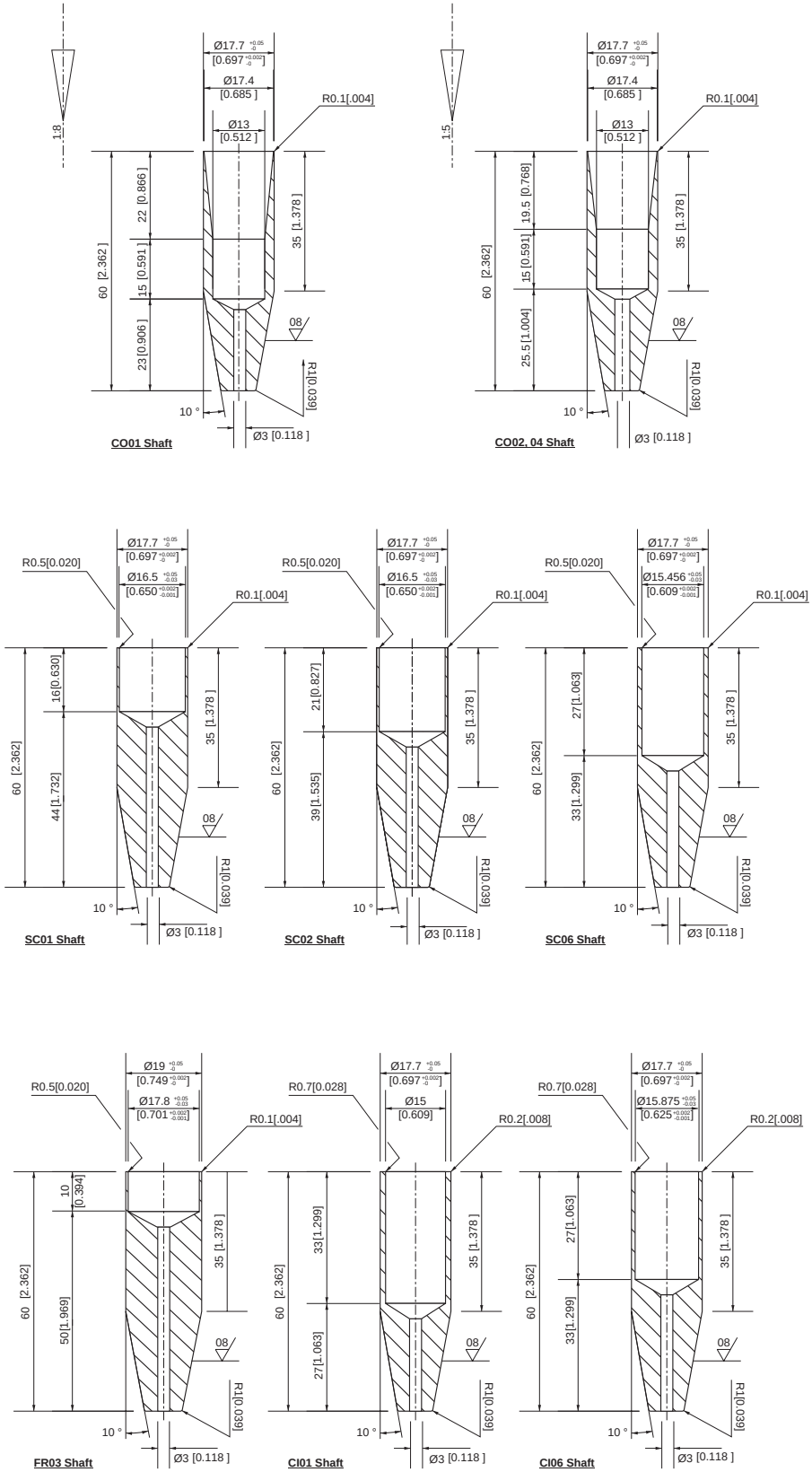
11.4.1 Shaft Seal Installation Tool



P101 138

11.4.2 Shaft Seal Protective Sleeves

mm [in]

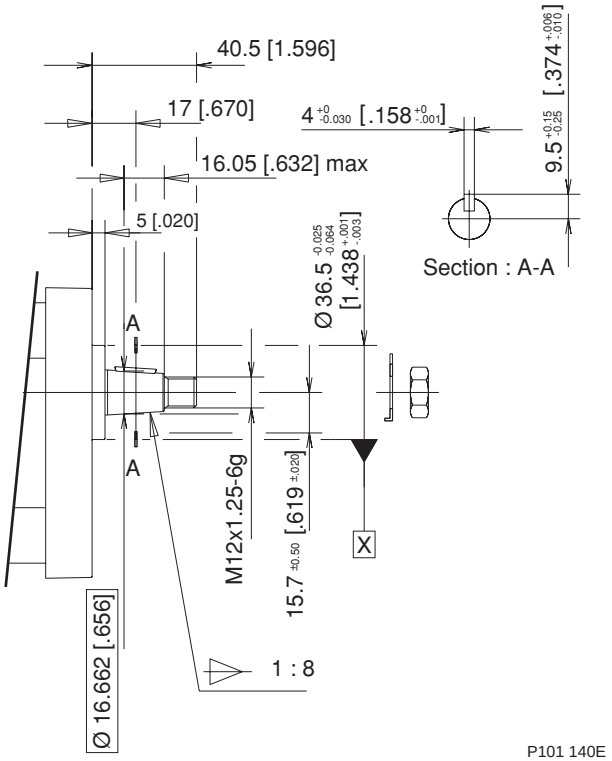


P101 139E

11.5 Shaft Dimensions

mm [in]

This section contains dimensions and specifications for standard shafts.



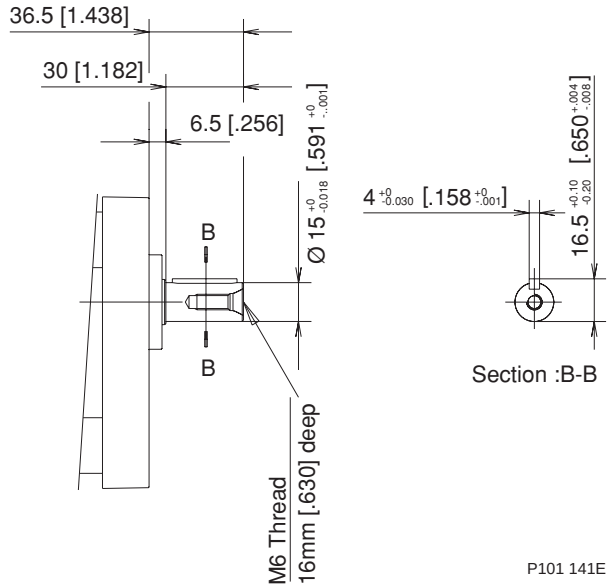
11.5.1 Shafts Used with 01 Flange

CO01 Tapered Shaft

Type:	1:8 Taper Shaft
Key Data:	4 x 6.5 ISO 3912

Technical Specifications:

Nut Torque:	35-50 Nm [26-37 lbf•ft]
Maximum Shaft Torque:	150 Nm [111 lbf•ft]



CI01 Parallel Shaft

Type:	Parallel
Key Data:	A 4x4x25 UNI 6604

Technical Specifications:

Maximum Shaft Torque:	90 Nm [66 lbf•ft]

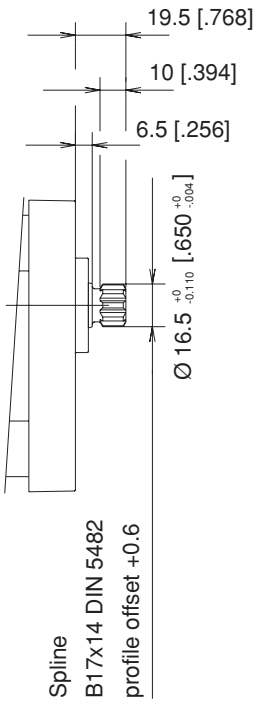
mm [in]

SC01 Splined Shaft

Type:	9 Tooth Spline
Spline Data:	17 x 14 DIN 5482
Circular Tooth Thickness (s_w):	3.206 mm
Profile Correction:	+ 0.6

Technical Specifications:

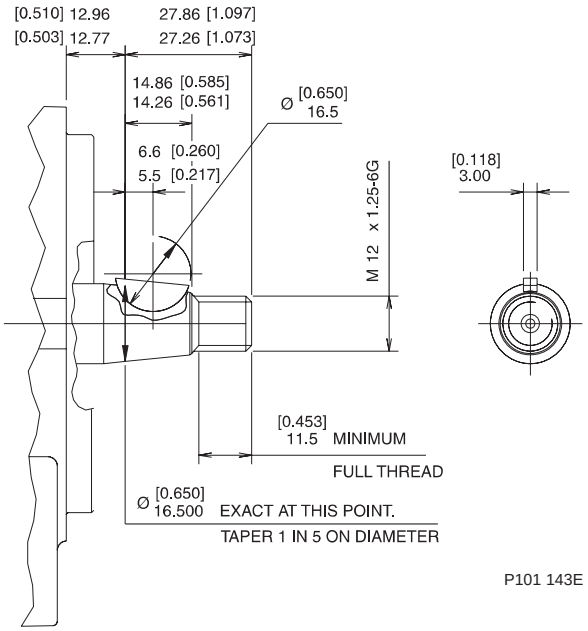
Maximum Shaft Torque:	90 Nm [66 lbf•ft]



P101 142E

mm [in]

11.5.2 Shafts Used with 02 Flange



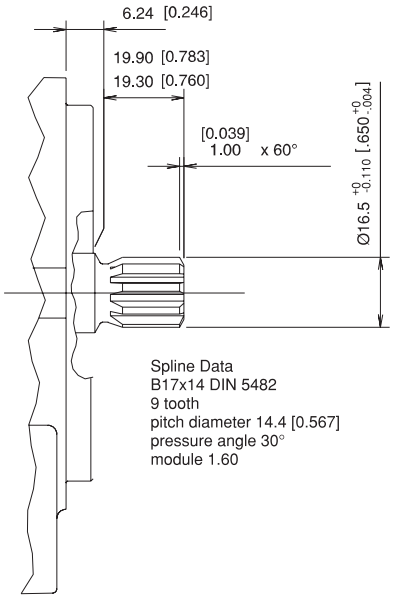
P101 143E

CO02 Taper Shaft

Type:	1:5 Taper Shaft
Key Data:	3 x 6.5 ISO 6604 (DIN 6888)

Technical Specifications:

Nut Torque:	40-50 Nm [30-37 lbf•ft]
Maximum Shaft Torque:	140 Nm [103 lbf•ft]



P101 144E

SC02 Splined Shaft

Type:	9 Tooth Spline
Spline Data:	17 x 14 DIN 5482
Circular Tooth Thickness (s_w):	3.206 mm
Profile Correction:	+ 0.6

Technical Specifications:

Maximum Shaft Torque:	130 Nm [96 lbf•ft]

mm [in]

11.5.3 Shafts Used with 04 / 05 Flange

CO04 / CO05 Taper Shaft

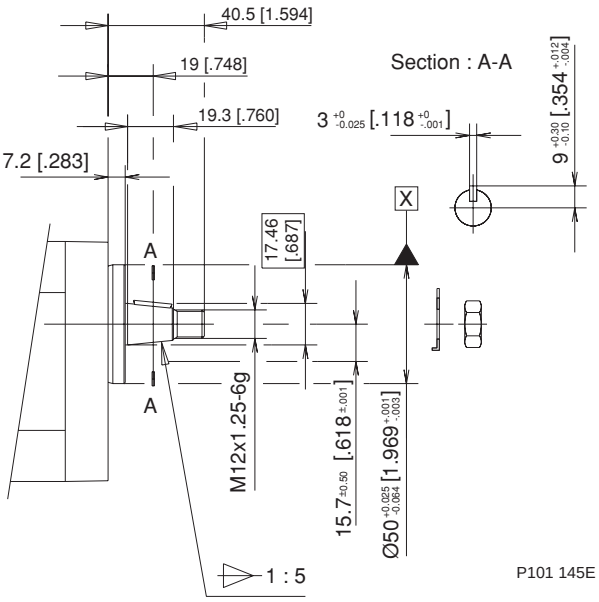
Type: 1:5 Taper Shaft

Key Data: 3 x 6.5 ISO 6604 (DIN 6888)

Technical Specifications:

Nut Torque: 40-50 Nm [30-37 lbf•ft]

Maximum Shaft Torque: 140 Nm [103 lbf•ft]



P101 145E

SC04 / SC05 Splined Shaft

Type: 9 Tooth Spline

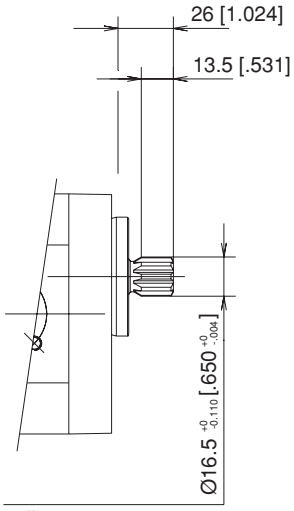
Spline Data: 17 x 14 DIN 5482

Circular Tooth Thickness (s_w): 3.206 mm

Profile Correction: + 0.6

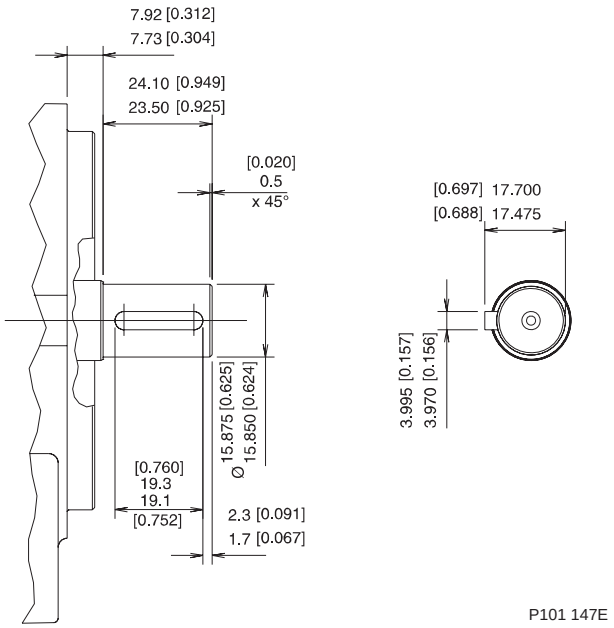
Technical Specifications:

Maximum Shaft Torque: 130 Nm [96 lbf•ft]



P101 146E

mm [in]



P101 147E

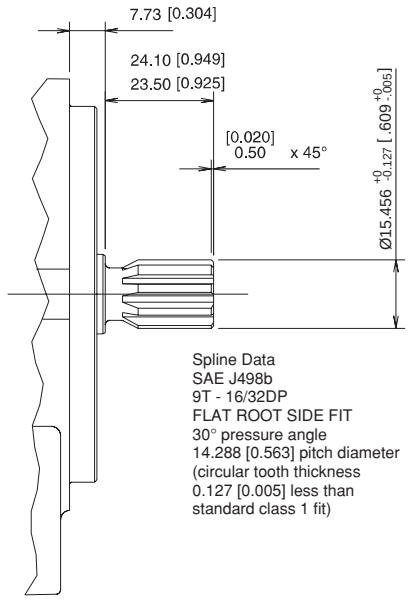
11.5.4 Shafts Used with 06 Flange (SAE)

Cl06 Parallel Shaft

Type: SAE A parallel Shaft

Technical Specifications:

Maximum Shaft Torque: 80 Nm
[59 lbf•ft]



P101 148E

SC06 Splined Shaft

Type: SAE 9 Tooth Spline

Spine Data: 9T 16/32DP
SAE J498b
flat root side fit

Circular Tooth Thickness: 0.127 mm [.005]
less than standard
SAE class 1 fit

Technical Specifications:

Maximum Shaft Torque: 75 Nm
[55 lbf•ft]

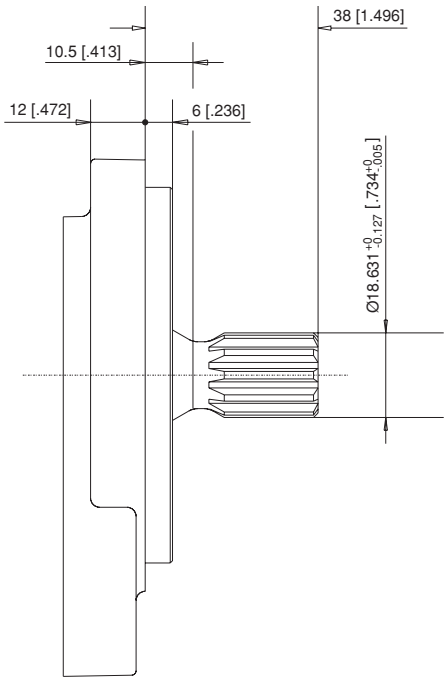
mm [in]

SKP2/...SC06 Splined Shaft

Type:	SAE 11 Tooth Spline
Spine Data:	11T 16/32DP SAE J498b flat root side fit
Circular Tooth Thickness:	0.127 mm [.005 in] less than standard SAE class 1 fit

Technical Specifications:

Maximum Shaft Torque:	150 Nm [111 lbf•ft]



P101 149E

11.5.5 FR Tang Shaft

mm [in]

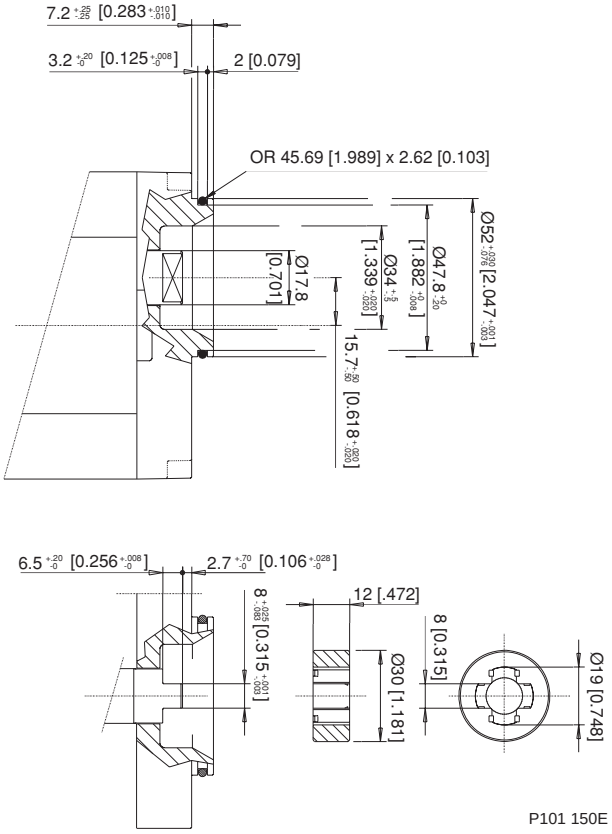
The shaft type shown in the drawing is called a “tang” shaft. This shaft is used in conjunction with an “Oldham” style coupling and is normally connected to another tang shaft on a P.T.O. (Power Take Off).

This shaft is generally supplied with the 03/43 type flange, and is used as the front drive for multistage pumps.

Caution: Due to the limited dimensions of the tang shaft, and to supply lubricating oil for the coupling, the 03/43 pumps are supplied without a front shaft seal. A shaft seal must be located on the P.T.O.

Technical Specifications:

Maximum Shaft Torque:	70 Nm [52 lbf•ft]



P101 150E

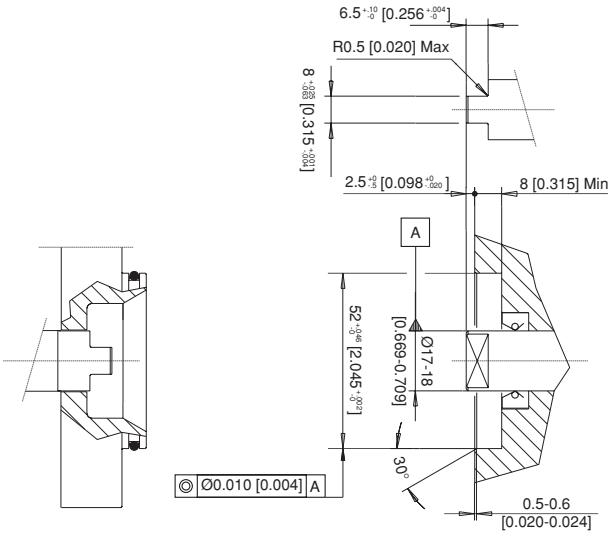
11.5.6 Mating Design for FR03 Pumps

The sketch of a P.T.O for the FR03 type pumps is shown. The axial dimensions and positions of the shaft must be strictly met. They are very important for correct torque transmission. The P.T.O. must have its own shaft seal.

To withstand the maximum torque capacity, the material of the P.T.O. shaft should be case hardened steel as per DIN 17210 or UNI 5331-64 at least 20 $MnCr_5$ (DIN), or 20 $CrNl_4$ (UNI), or better.

The pump mounting holes must be threaded per ISO M10, minimum full thread depth 20mm [0.787 in].

Capscrews used to attach the pump must be strength class 10.9. Torque 50-60 Nm [37-44 lbf•ft].



P101 151E

11.6 Flange Types

SNP 2/. . . CI 01
SEP 2/. . . CI 01

SNP 2/. . . CO 01
SEP 2/. . . CO 01
SHP 2/. . . CO 01

SNP 2/. . . SC 01
SEP 2/. . . SC 01

SNP 2/. . . CO 02
SHP 2/. . . CO 02

SNP 2/. . . SC 02

SNP 2/. . . FR 03

SNP 2/. . . CO 04

SNP 2/. . . SC 04

SNP 2/. . . CO 05

SNP 2/. . . SC 05

SNP 2/. . . CI 06

SNP 2/. . . SC 06

SNP 2/. . . CO 09

SNP 2/. . . CO 09. . . BBM

F101 061

Notes

Notes

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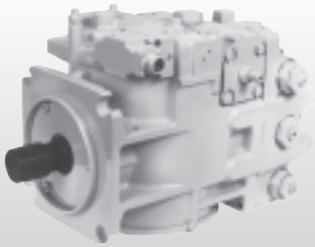
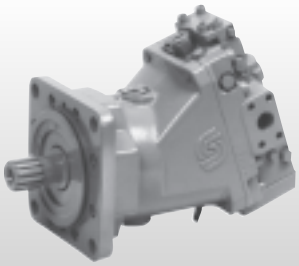
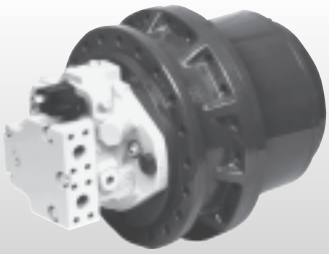


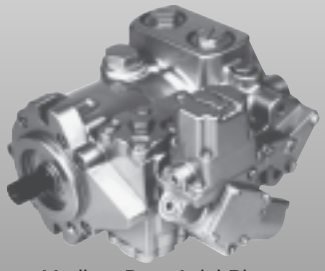
Heavy Duty Axial Piston Pumps and Motors



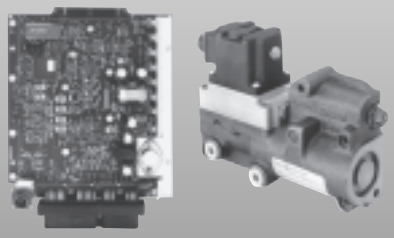
Heavy Duty Bent Axis Variable Motors



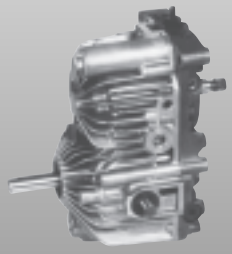
Cartridge Motors/ Compact Wheel Drives



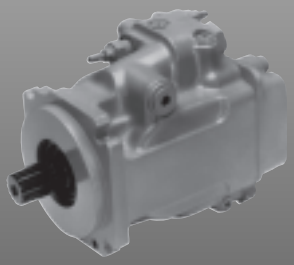
Medium Duty Axial Piston Pumps and Motors



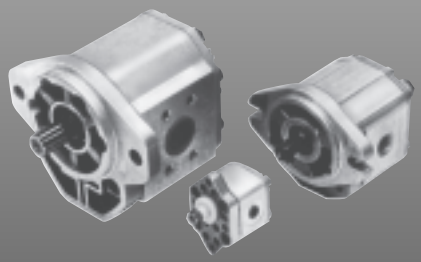
Mikrocontrollers and Electrohydraulic Controls



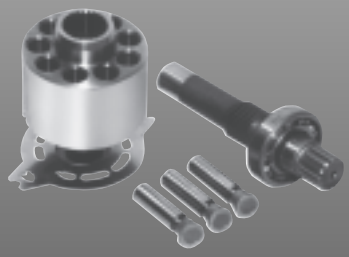
Hydrostatic Transmissions Packages



Open Circuit Axial Piston Pumps



Gear Pumps and Motors



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